NATIONAL FIRE PROTECTION ASSOCIATION
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TECHNICAL COMMITTEE ON
Energy Storage Systems
Second Draft Meeting Agenda for NFPA 855
August 26 – 29, 2024, Atlanta, GA

Continuation Meeting: October 1 - 3, 2024, Quincy, MA

1. **Call to Order.** James Biggins, Chair.
2. **Introduction of Committee Members.** See attached.
3. **Chairs Remarks.** James Biggins, Chair.
4. **Staff Presentation.** Chris Coache, Staff Liaison.
5. **Previous Meeting Minutes.** October 2023, see attached.
6. **NFPA 855 Second Draft.**
    a. **Public Comment Report.** See attached.
    b. **Task Group Reports**
7. **Other Business.**
8. **Future Meetings.**
9. **Adjournment.**

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MINUTES

NFPA Technical Committee on Energy Storage Systems (ESS-AAA)
NFPA 855 First Draft Meeting (A2025)

October 3-5, 2023
8 am – 5 pm (MST)

Hybrid Meeting
Salt Lake City, Utah

1. **Call to order.** James Biggins, chair, called the meeting to order at 8:30 am on October 3.
2. **Introductions.** Attendees introduced themselves and identified their affiliation and NFPA staff took attendance.
3. **Chair report.** James Biggins welcomed attendees and provided an overview of the meeting.
4. **Staff liaison report.** Christopher Coache provided an overview of the standards development process and the revision cycle schedule.
5. **Technical Committee Representation.** There were no declarations of representing another company, organization, or interest category.
6. **Previous meeting minutes.** The minutes from April 18 - 19, 2023 pre-First Draft meeting in Quincy, MA were approved without revision.
7. **NFPA 855 First Draft.**
    a. **Review of Public Inputs.** The Technical Committee reviewed the Public Inputs and developed First Revisions and Committee Inputs as necessary. These will be available in the First Draft Report at www.nfpa.org/855.
    b. **Task group reports.** The following task groups provided their reports and recommendations. Task group reports are attached.
        i. **TG 1 Rooftop PV and ESS TIA**. Chair Matt Paiss. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.
        ii. **TG 2 Explosion TIA**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.
        iii. **TG 3 Shipping of Batteries**. Chair Bob Davidson. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

iv. **TG 4 Explosion Issues**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

v. **TG 5 Charging Stations**. Chair Chris Towski. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

vi. **TG 6 HF Production**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

vii. **TG 7 ESS on Barges**. Chair Paul Rogers. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

viii. **TG 8 Technology Updates**. Chair Mike O’Brian. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

ix. **TG 9 Fire Protection**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

x. **TG 11 Emergency Response Plan**. Chair Brian Schol. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xi. **TG 16 2nd Life Use**. Chair Howard Hopper. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xii. **TG 19 Retroactivity**. Chair Curtis Ashton. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xiii. **TG 20 Flow Batteries**. Chair Matt Paiss. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xiv. **TG 21 Flywheel**. Chair Seth Sander. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xv. **TG 22 Certification**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

xvi. **TG 23 Definitions**. Chair Curtis Ashton. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

    xvii. **TG 24 Battery Exclusions**. Chair Bob Davidson. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

    xviii. **TG 25 Commissioning**. Chair Richard Kluge. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

    xix. **TG 26 References and Annex**. Chair Chris Searles. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

    xx. **TG 27 Standby Power**. Chair Paul Hayes. The task group provided a report on public inputs and proposed resolution or first revision as applicable. The task group was reconstituted to continue work.

  c. **Presentation(s).** The committee heard presentations from the following individuals.

    i. **IFC, ESS and NFPA 855.** Bob Davidson.

    ii. **[Iron-Air Batteries]**. Jarrod Milshtein, Alli Nansel, Andrew Rapin. Presentation attached.

  d. **New task groups.** The following task groups were appointed to work subsequent to the meeting. Additional task groups may be formed based on submitted public comments.

    i. **TG 28 NFPA 704**. TG Chair: Curtis Ashton. Members: Morris Stoops, Anthony Natale, Chris Towski, Jose Marrero, Randy Schuber. Address NFPA 704 application to ESS.

    ii. **TG 29 Maximum Energy**. TG Chair: Bob Davidson. Members: LaTonya Schwalb, Curis Ashton, Chris Searles, Ben Echeverria. Review layout and content of maximum energy tables.

    iii. **TG 30 Vehicle ESS**. TG Chair: Curtis Ashton. Members: Bob Davidson, Matt Paiss, Chad Kennedy, Justin Perry, Jody Leber, Chris Towski, Darryl Hill, Laura Stevens. Review requirements for use of vehicles as an ESS.

    iv. **TG 31 Emergency Operations Plan**. TG Chair: Morris Stoops. Members: Justin Perry, Anthony Natale, Paul Rogers, Gary Jasutis, Curtis Ashton, Chris Towski, Brian Scholl, Mike Maiz, Richard Kluge, Terry McKinch . Review requirements for emergency operations plans and coordinate with other NFPA standard requirements.

    v. **TG 32 Vehicle to Grid**. TG Chair: Jody Leber. Members: Chris Towski, LaTonya Schwalb, Ben Echeverria, Jose Marrero, Morris Stoops, Jim Barrett, Charles Pickard. Review requirements for vehicles as ESS by connection to the electrical grid.

    vi. **TG 33 Tables**. TG Chair: Matt Paiss. Members: Howard Hopper, LaTonya Schwalb, Steve Edley. Coordinate reference tables in all Chapters.

8. **Other Business.** None.

9. **Future meetings.** The next committee meeting will be October/November 2024. Proposed locations if the meeting is onsite are North or South Carolina. Public comments for the next edition are expected to close May 2024. A meeting notification will be posted at www.nfpa.org/855next when the next meeting is scheduled.

10. **Adjournment.** The meeting was adjourned at 7:30 on October 5.

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Anil Kapahi	Jensen Hughes
Dan Holiday	Industrial Fire Protection
Travis Stowers	AES
*Jason Torus	[Organization]
Andrew Blum	FRA
*Bryan Holland	NEMA
Benjamin Echeverria	Burns and McDonnell
*Maria Marks	Siemens
*Robert Rallo	Solar System Services
Christopher Groves	Wartsila
*Rachel Walker	[Organization]
*Patrick Reedy	Torus
Andrew Rapin	Form Energy
Samuel Stonerock	SCE
Brian Marchionini	NEMA
Grant Pierce	Stif Vigilex Energy
Robert Steele	Heller/AFT

Phil Friday	Reliable
Laura Stevens	Edwards (Carrier)
Erinc Eslik	Wartsila
*****Brian Baughman	NEMA
Frederick Rezler	Edwards/Kidde Engineered
Povl Hansen	Stif
Waylon Clark	Sandia National Laboratories
Patrick Reedy	Torus
Alli Nansel	Form Energy
Micheal O’Toole	Plus Power
Paul Rivers	Sidsson, LLS
Joe Cain	Solar Energy Industries Association
*****Michael Hart	Tesla
*****Sue Orlowski	SBCC
David Miller	McGriff
James Mongeau	AESI (ABS)
Greg Prosser	Vinko Solar
Steven Orlowski	Sundowne Building Code Consultants, LLC
Paul Greggory	BST&T Consultancy Services, Ltd.
Jarod Milshtein	Form Energy

*Participated by teleconference
Total number in attendance: 102

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.3.1.1.1	321	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.5.3.1.1.1 Installations shall ~~be permitted on rooftops of buildings that do~~ not obstruct fire department rooftop operations ~~when approved~~.		
First Revision Text (FR)	9.5.3.1.1.1 Installations shall ~~be permitted on rooftops of buildings that do~~ not obstruct fire department rooftop operations ~~when approved~~.		
Statement (technical reason for FR)	This is a simplification of the requirements,		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.3.1.1.2	9	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	9.5.3.1.1.2 ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following: (1) Stairway access to the roof for emergency response and fire department personnel shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building. (2) Service walkways at least 5 ft (1.5 m) in width shall be provided for service and emergency personnel from the point of access to the roof to the system. (3) ESS and associated equipment shall be located from the edge of the roof a distance equal to at least the height of the system, equipment, or component but not less than 5 ft (1.5 m). (4) The roofing materials under and within 5 ft (1.5 m) horizontally from an ESS or associated equipment shall be noncombustible or shall have a Class A rating when tested in accordance with ASTM E108 or UL 790. (5) A Class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level.		

	(6) Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted when approved by the AHJ. (7) Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes. (8) A thermal image or radiant energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS. (9) The ESS shall be a minimum of 10 ft (3 m) from the fire service access point on the rooftop.
First Revision Text (FR)	9.5.3.1.1.2 ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following: 1. Stairway access to the roof for emergency response and fire department personnel shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building. 2. Service walkways at least 5 ft (1.5 m) in width shall be provided for service and emergency personnel from the point of access to the roof to the system. 3. ESS and associated equipment shall be located from the edge of the roof a distance equal to at least the height of the system, equipment, or component but not less than 5 ft (1.5 m). 4. The roofing materials under and within 5 ft (1.5 m) horizontally from an ESS or associated equipment shall be noncombustible or shall have a Class A rating when tested in accordance with ASTM E108 or UL 790. 5. A Class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level. 6. Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted when approved by the AHJ. 7. Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes. 8. A radiant energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS. 9. The ESS shall be a minimum of 10 ft (3 m) from the fire service access point on the rooftop.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Specifying thermal imaging could limit other radiant energy heat detection technology.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
15.3.1	28	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.3.1 ESS Spacing. Individual ESS units shall be separated from each other by a minimum of 3 ft (914 mm) unless smaller separation distances are documented to be adequate based on fire and explosion testing complying with ~~9.1.5.~~ 15.13.		
First Revision Text (FR) (FROM TIA)	15.3.1 ESS Spacing. Individual ESS units shall be separated from each other by a minimum of 3 ft (~~914~~ 0.9 ~~m~~m) unless smaller separation distances are documented to be adequate based on fire and explosion testing complying with Section 15.13.		
Statement (technical reason for FR)	Change is based on accepted TIA 1727. Spacing and engineering requirements for fire and explosion reference to Chapter 9 requirements. This eliminates the requirement for a registered design professional with fire protection engineering expertise and replace that with language similar to what is currently found in NFPA 1, Section 1.16.1 when technical assistance is required by the AHJ (the IFC has similar language in 104.8.2). It allows an approved third party with expertise in energy storage to review the documents and provide the supplemental report. As the requirement is currently written, an installer could do the same installation at several homes in a jurisdiction, and they would need a registered design professional (e.g., FPE) for each installation. The new Section 15.13 on testing and certification matches how this topic (technical assistance for supplemental reports) is addressed in NFPA 1 Fire Code. The new requirements point to a new Section 15.3 with requirements specific to Chapter 15 only.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other Pis that propose revisions for this section	MOTION
New 15.12	29	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.12* Test Reports ESS installed in accordance with Chapter 15 shall be provided with a product-level evaluation by an approved qualified person with expertise in energy storage as a supplemental safety document to be used by the AHJ and the installing contractors. A.15.12 The test report will provide information that, among other things, describes the size and energy capacity rating of the unit being tested, model numbers of the modules and ESS units, the orientation of ESS in the test facility, and the proximity of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of test results		

	and measurements. For example, a complete UL 9540A test report that includes a unit-level test should also include the UL 9540A cell and module-level test.
First Revision Text (FR) (FROM TIA)	15.12* Test Reports. ESS installed in accordance with Chapter 15 shall be provided with a product-level evaluation by an approved qualified person with expertise in energy storage as a supplemental safety document to be used by the AHJ and the installing contractors. A.15.12 The test report will provide information that, among other things, describes the size and energy capacity rating of the unit being tested, model numbers of the modules and ESS units, orientation of ESS in the test facility, and proximity of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of test results and measurements. For example, a complete UL 9540A test report that includes a unit-level test should also include the UL 9540A cell and module-level test.
Statement (technical reason for FR)	Change is based on accepted TIA 1727. Spacing and engineering requirements for fire and explosion reference to Chapter 9 requirements. This eliminates the requirement for a registered design professional with fire protection engineering expertise and replace that with language similar to what is currently found in NFPA 1, Section 1.16.1 when technical assistance is required by the AHJ (the IFC has similar language in 104.8.2). It allows an approved third party with expertise in energy storage to review the documents and provide the supplemental report. As the code is currently written, an installer could do the same installation at several homes in a jurisdiction, and they would need a registered design professional (e.g., FPE) for each installation. The new Section 15.13 on testing and certification matches how this topic (technical assistance for supplemental reports) is addressed in NFPA 1 Fire Code. The new requirements point to a new Section 15.3 with requirements specific to Chapter 15 only.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 15.13	30	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.13 Fire and Explosion Testing. 15.13.1* Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standards. A.15.13.1 A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of gases generated at the cell, module, and unit and installation levels for ESS undergoing thermal runaways, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level installation level		

	testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The fire and explosion testing data is intended to be used by manufacturers, system designers, and AHJs to determine if the required separation distance for an ESS installation can be reduced. 15.13.1.1 The complete UL 9540A or equivalent test report shall be provided to the Authority Having Jurisdiction, including the cell, module, and unit level. 15.13.1.2 Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when installed with a charging system listed to UL 1012, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778. 15.13.1.3 The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit. 15.13.1.4* The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation. A.15.13.1.4 changes in an installation configuration, including the internal architecture of modules and units that don't match the parameters tested, such as size and separation, cell type, or energy density, should only be accepted if it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might have yet to be evaluated in the test. 15.13.1.5 The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.
First Revision Text (FR) (FROM TIA)	15.13 Fire and Explosion Testing. 15.13.1* Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standards. A.15.13.1 A UL 9540A or equivalent test should evaluate the fire characteristics of the composition of gases generated at the cell, module, and unit and installation levels for ESS undergoing thermal runaways, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit- level and installation-level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The fire and

	explosion testing data is intended to be used by manufacturers, system designers, and AHJs to determine if the required separation distance for an ESS installation can be reduced. 15.13.1.1 The complete UL 9540A or equivalent test report shall be provided to the authority having jurisdiction, including the cell, module, and unit level. 15.13.1.2 Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when installed with a charging system listed to UL 1012, UL 1741, CAN/CSA C22.2 No. 107.2, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778. 15.13.1.3 The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit. 15.13.1.4* The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation. A.15.13.1.4 Changes in an installation configuration, including the internal architecture of modules and units that don't match the parameters tested, such as size and separation, cell type, or energy density, should only be accepted if it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might have yet to be evaluated in the test. 15.13.1.5 The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.
Statement (technical reason for FR)	Change is based on accepted TIA 1727. Spacing and engineering requirements for fire and explosion reference to Chapter 9 requirements. This eliminates the requirement for a registered design professional with fire protection engineering expertise and replace that with language similar to what is currently found in NFPA 1, Section 1.16.1 when technical assistance is required by the AHJ (the IFC has similar language in 104.8.2). It allows an approved third party with expertise in energy storage to review the documents and provide the supplemental report. As the code is currently written, an installer could do the same installation at several homes in a jurisdiction, and they would need a registered design professional (e.g., FPE) for each installation. The new Section 15.13 on testing and certification matches how this topic (technical assistance for supplemental reports) is addressed in NFPA 1 Fire Code. The new requirements point to a new Section 15.3 with requirements specific to Chapter 15 only.

	Additional information is added for the acceptable listing requirements for standby power exception. Most residential systems use a UL 1741 listed inverter/charger and needs to be references in the exception. The Canadian standard is also added.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.6	144 (TIA 20-2)	253, 150, 71, 75	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	~~4.12~~ 9.6.5.6* A.~~4.12~~ 9.6.5.6 During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS, in particular electrochemical batteries and capacitors, begin off-gassing flammable and toxic gases, which can include mixtures of CO, H2, ethylene, methane, benzene, HF, HCl, and HCN. Among other things, these gases present an explosion hazard that needs to be mitigated. Explosion control is provided to mitigate this hazard. Both the exhaust ventilation requirements of Section 4.9 and the explosion control requirements of Section 4.12 are designed to mitigate hazards associated with the release of flammable gases in battery rooms, ESS cabinets, and ESS walk-in units. The difference is that exhaust ventilation is intended to provide protection for flammable gases released during normal charging and discharging of battery systems since some electrochemical ESS technologies such as vented lead-acid batteries release hydrogen when charging. In comparison, the Section 4.12 provisions are designed to provide protection for electrochemical ESS during an abnormal condition, such as thermal runaway, which can be instigated by physical damage, overcharging, short circuiting, and overheating of technologies such as lithium-ion batteries, which do not release detectable amounts of flammable gas during normal charging and discharging, but which can release significant quantities of flammable gas during a thermal event. ~~4.12.1~~ 9.6.5.6.3* * ESS installed within a room, building, ESS cabinet, or ESS walk-in unit shall be provided with one of the following: (1) Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69 (2) Deflagration venting installed and maintained in accordance with NFPA 68 A.~~4.12.1~~ 9.6.5.6.3* This requirement recognizes that some cabinet designs with low internal volume, the application of NFPA 68 or NFPA 69 might not be practical. It is possible that a quantitative explosion analysis is necessary to show there is no threat to life and safety. As an example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit level and installation level test identified in 4.1.5 will provide the test data referenced in this section, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet. NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the combustion gases generated during the cell, module and		

	installation level testing under UL 9540A must be utilized in applying a NFPA 68 solution. Where the likelihood for detonation exists, alternative solutions, such as those in NFPA 69, should be considered. NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods: (1) Control of oxidant concentration (2) Control of combustible concentration (3) Pre-deflagration detection and control of ignition sources (4) Explosion suppression (5) Active isolation (6) Passive isolation (7) Deflagration pressure containment (8) Passive explosion suppression Due to possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries, combustible gas concentration reduction can be a viable mitigation strategy. Gas detection and appropriate interlocks can be used based on appropriate evaluation under a NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL, but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL 2) instrumented safety system rating. Data on flammable gas composition and release rates, such as that included in UL 9540A large-scale fire testing, provide the information needed to design effective explosion control systems. ~~4.12.1.1~~ 9.6.5.6.1.1 Explosion prevention and deflagration venting shall not be required where approved by the AHJ based on large-scale testing in accordance with 4 9.1.5 and a deflagration hazard study that demonstrates that flammable gas concentrations in the room, building, ESS cabinet, or ESS walk-in unit cannot exceed 25 percent of the LFL. ~~4.12.1.2~~ 9.6.5.6.4* Where approved, ESS cabinets that have been designed to ensure no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation level large-scale testing and engineering evaluation complying with 4 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control complying with NFPA 68 or NFPA 69.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	NOTE: This public input originates from Tentative Interim Amendment No. 20-2 (Log 1585) issued by the Standards Council on August 26, 2021 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document. Substantiation: NFPA 855 Chapter 4.12 listed only rooms building and walk in units under the requirements for explosion control. At the time of the first addition of NFPA 855 it was not evident that the changes in the industry to smaller containers would require the term “cabinets” be included for this chapter and be explicitly stated. The exclusion of “cabinets” in chapter 4.12 has had unintended consequences. It has led to the perception of some in the industry that ESS cabinets do not require explosion control. Some in the industry have assumed that since ESS cabinets were not include in the description they most be exclude. Use of this “loophole” can lead to what the TC would consider an unsafe installation. This TIA is submitted so that minimum levels of safety are required for all installations and to eliminate the unstated exception. In order to

<table>
<tr><td></td><td colspan="3">correct this exclusion, we are recommending “cabinets” be explicitly stated in chapter 4.12. It was also determined that language should be added to address pressure waves, shrapnel, and container pieces. Additional guidance is added to the annex for clarification.

Changes Moved from 4.12 to Chapter 9</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>9.6.5.6</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>253</td><td>144, 71, 171, 72, 189, 76, 341, ~~104~~, 129, ~~79~~, 80, 78</td><td>☒~~☐~~ Create First Revision

☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6* Explosion Control.

9.6.5.6.1

Where required elsewhere in this standard, explosion prevention or deflagration venting shall be provided in accordance with this section.

9.6.5.6.1.1

Explosion prevention and deflagration venting shall not be required where approved by the AHJ based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study demonstrating that flammable gas concentrations cannot ~~exceed~~ accumulate exceeding 25 percent of the LFL~~.~~ in any area of a cabinet or area of a room the ESS is located within has been submitted to the AHJ for review and approval.

9.6.5.6.1.2

Explosion control shall not be required for the following:

(1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76

(2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations that follow the guidelines of IEEE 1635/ASHRAE 21

(3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units that follow the guidelines of IEEE 1635/ASHRAE 21

(4) ~~Lead-acid and Ni-Cd batteries listed in accordance with UL 1973~~

(5) Batteries ~~listed in accordance with UL 1973~~ that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test

9.6.5.6.2</td></tr>
</table>

Protection against the release of flammable gases during normal operation shall be in accordance with 9.6.5.1.

9.6.5.6.3*

ESS installed within a room, building, ESS cabinet, ESS walk-in unit, or otherwise nonoccupiable enclosure shall be provided with one of the following:

(1) Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69

(2) Deflagration venting installed and maintained in accordance with NFPA 68

9.6.5.6.4*

Where approved, ESS cabinets designed to ensure that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation level fire and explosion testing and an engineering evaluation complying with 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control that complies with NFPA 68 or NFPA 69.

9.6.5.6.5

ESS ~~enclosures~~ walk-in units and ESS cabinets shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5 that includes the ESS enclosure and cabinets.

9.6.5.6.6*

Where ESS ~~batteries~~ walk-in units or ESS cabinets are installed ~~in~~ within a container outdoors ~~, other than a walk-in unit,~~ or within a room or building space the installation shall comply with ~~one~~ both of the following:

(1) ~~The container~~ ESS walk-in unit or ESS cabinet shall be provided with explosion control complying with 9.6.5.6.3.

(2) ~~Combination of the container and cabinets shall be tested together to show compliance with~~ The Room or container they are installed within shall be provided with explosion control complying with 9.6.5.6.~~1~~3~~.1~~.

9.6.5.6.7

Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.

(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.

(3) The gas detection system ~~and combustible gas concentration reduction system~~ shall be ~~provided with a minimum of 2 hours of standby power~~ installed in accordance with NFPA 72.

<table>
<tr><td></td><td colspan="3">(4) For lithium-ion batteries, the combustible gas ~~detection~~ reduction system shall be provided with ~~a minimum of 24 hours of standby power and 2 hours in alarm or as required~~ emergency power for the duration of time a potential deflagration hazard would exist should an uncontrolled thermal runaway event occur as documented by the HMA.
(5) The gas detection system shall annunciate annunciation means shall be located as required by the authority having jurisdiction to facilitate an efficient response to the situation and alarm signals shall be transmitted to a supervising station in accordance with NFPA 72,~~the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location:~~
~~(a) A trouble signal upon failure of the gas detection system~~
~~(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL~~
9.6.5.6.8
Compartmentalization created by cold and hot aisle arrangements within the ESS ~~enclosure~~ walk-in unit or ESS cabinet shall be addressed in accordance with the following:
(1) For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment.
(2) For NFPA 68 designs, the placement of explosion relief panels shall ensure that the explosion hazard is addressed for both hot and cold aisles/subcompartments.
(3) The gas detection system shall be designed to activate on detection of flammable gas in either aisle/subcompartment.
9.6.5.6.9
The protection design shall demonstrate that deflagrations are not propagated to interconnected or adjacent cabinets, enclosures, or rooms.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The proposed change clarifies the exempt report requirements, adds standards as a condition of Eliminates the reference to UL 1973 as a qualifier since the it does not prevent the hazard; clarifies the application to ESS walk-in units and ESS cabinets.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Power requirements resolved and addressed under separate PI's,
Section 9.6.5.6.7 was adjusted under PI 79,253,104,129 to include other committee inputs
Section 9.6.5.6.6 was deleted under other committee inputs.</td></tr>
<tr><td rowspan="2">A.9.6.5.6</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>150</td><td>144</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.9.6.5.6
During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS, in particular electrochemical batteries and capacitors, begin off-gassing flammable and toxic gases, which can include mixtures of CO, H_2, ethylene, methane, benzene, HF, HCl, and HCN. Among</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">other things, these gases present an explosion hazard that needs to be mitigated. Explosion control is provided to mitigate this hazard.
Both the exhaust ventilation requirements of 9.6.5.1 and the explosion control requirements of 9.6.5.6 are designed to mitigate hazards associated with the release of flammable gases in battery rooms, ESS cabinets, and ESS walk-in units. The difference is that exhaust ventilation is intended to provide protection for flammable gases released during normal charging and discharging of battery systems since some electrochemical ESS technologies such as vented lead-acid batteries release hydrogen when charging.
In comparison, the 9.6.5.6 provisions are designed to provide protection for electrochemical ESS during an abnormal condition, such as thermal runaway, which can be instigated by physical damage, overcharging, short circuiting, and overheating of technologies such as lithium-ion batteries, which do not release detectable amounts of flammable gas during normal charging and discharging but can release significant quantities of flammable gas during a thermal event.
VRLA battery systems, if abused or neglected for long periods of time, may go into thermal walkaway. This condition is not to be confused with thermal runaway as seen in lithium-ion batteries. Much less heat and gas is produced (see IEEE 1635/ASHRAE 21) so explosion control is not needed. Safety concerns are covered by ventilation requirements in 9.6.5.1. Thermal walkaway in VRLA batteries is typically prevented by use of temperature compensated charging.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Explosion control has never been an issue with lead-acid or nickel-cadmium batteries. If ventilation requirements as outlined in 9.6.1 are ignored, then a possible explosive situation could develop over time. However, requiring specific explosion control or deflagration equipment is not necessary.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>337</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.1
Where required elsewhere in this standard, explosion prevention or deflagration venting shall be provided in accordance with this section to safeguard against the release of flammable gases during abnormal charging or thermal runaway conditions.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Additional input and clarification for abnormal conditions. Also removed Deflagration venting as this is a subset of Explosion control.</td></tr>
</table>

Response (technical reason for not making some changes or for resolving)			
9.6.5.6.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	71~~, part 253~~	144. ~~253~~	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.1.1 Explosion prevention ~~and deflagration venting~~ shall not be required ~~where approved by the AHJ~~ based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study ~~demonstrating that~~ has been submitted to the AHJ for review and approval that demonstrates that flammable gas concentrations cannot ~~exceed~~ accumulate exceeding an average of 25 percent of the LFL.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	Clean up requirement for explosion control without reference to options, and noting "accumulation" of gas as more accurate term than "exceeding" with the clarification added that the limit is on average for the defined space.		
Response (technical reason for not making some changes or for resolving)			
9.6.5.6.1.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	171	253, 72, 189	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.1.2 Explosion control shall not be required for the following: (1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 (2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations (3) Lead-acid battery systems in ~~uninterruptable~~ uninterruptible power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units		

<table>
<tr><td></td><td colspan="3">(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 used in system 600Vdc or less.
(5) Batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Corrected the term “uninterruptable” as a typo.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Item 4 was deleted for better clarification of item 5.</td></tr>
<tr><td rowspan="2">9.6.5.6.1.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>189</td><td>253, 171, 72</td><td>☐ Create First Revision
☒☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.1.2
Explosion control shall not be required for the following:
(1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76
(2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations
(3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units
(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973
(5) Batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some</td><td colspan="3">Modified as part of PI 72</td></tr>
</table>

changes or for resolving)			
9.6.5.6.1.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	72, part 253 189	171, 189	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.1.2 Explosion control following this standard shall not be required for the following: (1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 (2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations that comply with the National Electric Safety Code or follow the guidelines of IEEE 1635/ASHRAE 21. (3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units that follow the guidelines of IEEE 1635/ASHRAE 21. (4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 (5) Batteries ~~listed in accordance with UL 1973~~ that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	Adding clarifying conditions that support the exclusion of selected technologies by identifying the standards of IEEE 1635 and ASHRAE 21. Makes the conditions of exception more stringent.		
Response (technical reason for not making some changes or for resolving)			
9.6.5.6.1.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	Carry over from PI 27, part 253,	253, 171, 72, 189	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.1.2 Explosion control shall not be required for the following: (1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of		

<table>
<tr><td></td><td colspan="3">communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76
(2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or ~~safe~~ shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations
(3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units
(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973
(5) Batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Remove Safe as not defined.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New 9.6.5.6.1.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>262</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.1.3
Explosion prevention or deflagration venting analysis and design shall be bases upon the gas composition and volume identified by fire and explosion testing conducted in accordance with 9.1.5.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The standard does not identify how the gas composition and volume of a thermal runaway event is to be determined for the purpose of use in and NFPA 68 or NFPA 69 solution.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>338</td><td>None</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
</table>

Proposed Text (PI)	~~9.6.5.6.2~~ ~~Protection against the release of flammable gases during normal operation shall be in accordance with 9.6.5.1.~~		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The section provides clarification between normal and abnormal operations and should be retained.		
9.6.5.6.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	73	144	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.3* ~~ESS installed within a room, building, ESS cabinet, ESS walk-in unit, or otherwise nonoccupiable enclosure~~ All ESS shall be provided with ~~one of the following:~~ ~~(1)~~ Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69 ~~2) Deflagration venting installed and maintained in accordance with NFPA 68~~.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	This change removes multiple area designations as they just cause confusion especially as technologies change. Simplify requirement to all ESS. Additional remove the option for NFPA 68 compliance as for large scale gas deflagrations, they have not shown to be effective at mitigating the pressure release.		
Response (technical reason for not making some changes or for resolving)			
A.9.6.5.6.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	74	144	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.9.6.5.6.3 The requirement recognizes that with some cabinet designs that have low internal volume, the application of ~~NFPA 68 or~~ NFPA 69 might not be practical. It is possible that a quantitative		

	explosion analysis is necessary to show there is no threat to life and safety. For example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit level and installation level test identified in 9.1.5 will provide the test data referenced in 9.6.5.6.3, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet. While NFPA 68 has been an approved method for explosion mitigation it is no longer a singular approved method, it may be provided as a supplement of NFPA 69 solutions in certain high-risk applications. If it is used as a supplementary explosion control option, then 9.6.5.6.4 would be required as a large-scale test. NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the combustion gases generated during the cell, module, and installation level testing under UL 9540A must be used when applying a NFPA 68 solution. Where the likelihood for detonation exists, alternative solutions such as ~~those in NFPA 69~~ automatic door opening systems should be considered. NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods: (1) Control of oxidant concentration (2) Control of combustible concentration (3) Pre-deflagration detection and control of ignition sources (4) Explosion suppression (5) Active isolation (6) Passive isolation (7) Deflagration pressure containment (8) Passive explosion suppression Combustible gas concentration reduction can be a viable mitigation strategy for possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries. Gas detection and appropriate interlocks can be used based on appropriate evaluation under an NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL) 2 instrumented safety system rating. Data on flammable gas composition and release rates, such as that included in UL 9540A fire and explosion testing, provide the information needed to design effective explosion control systems.
First Revision Text (FR)	See below for revised text.

<table>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">Removal of NFPA 68 as in option in 9.6.5.6.3 requires additional clarification and modification in the annex. Information added that still allows NFPA 68 as a supplementary option to NFPA 69 solutions.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.4</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>75</td><td>144, 253</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.4*
Where approved, ESS ~~cabinets~~ shall be designed to ensure that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation level fire and explosion testing and an engineering evaluation performed by a Registered Design Professional complying with 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control that complies with ~~NFPA 68 or~~ NFPA 69.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">Providing the defined term of Registered Designed professional. Also removed NFPA 68 as an option. The committee feels that NFPA 68 as a standalone option is not viable.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New 9.6.5.6.4</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>339</td><td>253, 76</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.4
ESS enclosures and cabinets shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5 that includes the ESS enclosure and cabinets.
9.6.5.6.~~4~~5*
Where approved, ESS cabinets designed to ensure that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation level fire and explosion testing and an engineering evaluation complying with 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control that complies with NFPA 68 or NFPA 69.
~~9.6.5.6.5~~</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">~~ESS enclosures and cabinets shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5 that includes the ESS enclosure and cabinets.~~</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">No technical change, these requirements should be reversed so that the design and testing per 9.1.5 comes first, and based on that the AHJ could approve forgoing NFPA 69.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>9.6.5.6.5</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>76</td><td>253</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.5*
~~ESS enclosures and cabinets~~ Independent ESS cabinets installed in larger BESS configuration such rooms, buildings, or containers shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5 that includes the ESS ~~enclosure and~~ cabinets~~.~~ and the space they are installed within.
A.9.5.6.5
This condition effectively creates a "box in a box". A deflagration inside the smaller box can adversely impact the larger box and must be evaluated independently.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The requirements of the section were not clear on the concept of a explosion of a "Box in a box". edited to clarify and explain this concept.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>9.6.5.6.6</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>341</td><td>253</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.6*</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">Where ESS batteries or cabinets are installed in a container outdoors, other than a walk-in unit, the installation shall comply with one of the following:
(1) The container shall be provided with explosion control complying with 9.6.5.6.3.
(2) ~~Combination~~ The AHJ has approved fire and explosion test results of the combination of the container and cabinets ~~shall be tested together to show compliance with~~ in accordance with 9.~~6~~1.5~~.6.1.1.~~ and a deflagration hazard study demonstrating that flammable gas concentrations cannot exceed 25 percent of the LFL.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Because of change in prior sections, this section has been deleted.</td></tr>
<tr><td>9.6.5.6.6</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>77</td><td>253, 341</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">~~9.6.5.6.6*~~
~~Where ESS batteries or cabinets are installed in a container outdoors, other than a walk-in unit, the installation shall comply with one of the following:~~
~~(1) The container shall be provided with explosion control complying with 9.6.5.6.3.~~
~~(2) Combination of the container and cabinets shall be tested together to show compliance with 9.6.5.6.1.1.~~</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">With edits in prior sections, this section is no longer needed. Explosion requirements for a box in a box have been updated.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>104,79, 253, 129,</td><td>~~253, 129, 79~~</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
</table>

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power or as required by the HMA.
(4) For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.
(5) The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location:
(a) A trouble signal upon failure of the gas detection system
(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">additional clarity added for standby power tied to the new 4.10 section; locations that a failed condition must be annunciated for First responder protection. Additional sections were added for the survivability evaluation of the 69 system; interaction requirements between suppression system; and NFPA 69 system and inspection requirements for the 69 systems.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>129</td><td>253, 104, 79</td><td>☒☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.
(4) For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.
(5) The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location:
(a) A trouble signal upon failure of the gas detection system
(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">See PI 104</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>79</td><td>253, 104, 129</td><td>☒☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
(3) The gas detection ~~system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power~~ .
(4) For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.</td></tr>
</table>

	(5) The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location: (a) A trouble signal upon failure of the gas detection system. (b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	See PI 104		
Response (technical reason for not making some changes or for resolving)			
9.6.5.6.8	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	80	~~253~~	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.8 Compartmentalization created by cold and hot aisle arrangements within the ESS enclosure shall be addressed in accordance with the following: (1) For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment. (2) ~~For NFPA 68 designs, the placement of explosion relief panels shall ensure that the explosion hazard is addressed for both hot and cold aisles/subcompartments.~~ (3) The gas detection system shall be designed to activate on detection of flammable gas in either aisle/subcompartment.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	NFPA 68 and explosion panels are not a viable option for explosion mitigation in duct work and HVAC system internal to a BESS. Creates a box in a box type deflagration.		
Response (technical reason for not making some changes or for resolving)			
New 9.6.5.6.8	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

	85	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	9.6.5.6.8 Reliable Power Requirements Currently 855 nor NFPA 69 provide definitions or expectations of what can and should be considered to be reliable power to support the functions of the safety systems in a failure situation - Recommend the technical committee or Task Group provide better guidance to industry on expectations of back and reliable power.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	This is covered in the TG for Power and new section 4.10		
Response (technical reason for not making some changes or for resolving)			
9.6.5.6.9	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	78	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.6.9 The protection design shall demonstrate that ~~deflagrations~~ deflagration are not propagated to interconnected or adjacent ~~cabinets, enclosures, or rooms~~ BESS.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	This simplifies from BESS specific configurations to only BESS. As technologies change the requirements for no propagation between systems will apply to any BESS configuration.		
Response (technical reason for not making some changes or for resolving)			
First Revision Text (FR)			
9.6.5.6* Explosion Control. (PI 144) A.9.6.5.6 (PI 150) During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS, in particular electrochemical batteries and capacitors, begin off-gassing flammable and toxic gases,			

which can include mixtures of CO, H2, ethylene, methane, benzene, HF, HCl, and HCN. Among other things, these gases present an explosion hazard that needs to be mitigated. Explosion control is provided to mitigate this hazard.

Both the exhaust ventilation requirements of 9.6.5.1 and the explosion control requirements of 9.6.5.6 are designed to mitigate hazards associated with the release of flammable gases in battery rooms, ESS cabinets, and ESS walk-in units. The difference is that exhaust ventilation is intended to provide protection for flammable gases released during normal charging and discharging of battery systems since some electrochemical ESS technologies such as vented lead-acid batteries release hydrogen when charging.

In comparison, the 9.6.5.6 provisions are designed to provide protection for electrochemical ESS during an abnormal condition, such as thermal runaway, which can be instigated by physical damage, overcharging, short circuiting, and overheating of technologies such as lithium-ion batteries, which do not release detectable amounts of flammable gas during normal charging and discharging but can release significant quantities of flammable gas during a thermal event.

VRLA battery systems, if abused or neglected for long periods of time, may go into thermal walkaway. This condition is not to be confused with thermal runaway as seen in lithium-ion batteries. Much less heat and gas is produced (see IEEE 1635/ASHRAE 21) so explosion control is not needed. Safety concerns are covered by ventilation requirements in 9.6.5.1. Thermal walkaway in VRLA batteries is typically prevented by use of temperature compensated charging.

9.6.5.6.1 (PI 337)

Where required elsewhere in this standard, explosion prevention ~~or deflagration venting~~ shall be provided in accordance with this section to safeguard against the release of flammable gases during abnormal charging or thermal runaway conditions.

9.6.5.6.1.1 (PI 253, 71)

Explosion prevention ~~and deflagration venting~~ shall not be required ~~where approved by the AHJ~~ based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study has been submitted to the AHJ for review and approval that demonstrates~~ing~~ that flammable gas concentrations cannot ~~exceed~~ accumulate exceeding 25 percent of the LFL in the BESS.

9.6.5.6.1.2 (PI-72, 171, 189, 253)

Explosion control following this standard shall not be required for the following:

1. Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76

2. Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such

installations that complies with the National Electric Safety Code or follow the guidelines of IEEE 1635/ASHRAE 21

3. Lead-acid battery systems in ~~uninterruptable~~ uninterruptible power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units that follow the guidelines of IEEE 1635/ASHRAE 21

~~4. Lead-acid and Ni-Cd batteries listed in accordance with UL 1973~~

~~5.~~4. Lead-acid and Ni-Cd ~~B~~batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test.

9.6.5.6.1.3 (PI 262)

Explosion prevention or deflagration venting analysis and design shall be bases upon the gas composition and volume identified by fire and explosion testing conducted in accordance with 9.1.5.

9.6.5.6.2 (PI 338-R)

Protection against the release of flammable gases during normal operation shall be in accordance with 9.6.5.1.

9.6.5.6.3* (PI 73)

All ESS ~~installed within a room, building, ESS cabinet, ESS walk-in unit, or otherwise nonoccupiable enclosure~~ shall be provided with a reliable explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69 . ~~one of the following:~~

~~1. Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69~~

~~2. Deflagration venting installed and maintained in accordance with NFPA 68~~

A.9.6.5.6.3 (PI 74)

The requirement recognizes that with some cabinet designs that have low internal volume, the application of ~~NFPA 68 or~~ NFPA 69 might not be practical. It is possible that a quantitative explosion analysis is necessary to show there is no threat to life and safety. For example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit level and installation level test identified in 9.1.5 will provide the test data referenced in 9.6.5.6.3, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet.

While NFPA 68 has been an approved method for explosion mitigation it is no longer a singular approved method, it may be provided as a supplement of NFPA 69 solutions in certain high-risk applications. If it is used as a supplementary explosion control option, then 9.6.5.6.4 would be required as a large-scale test. NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the combustion gases generated during the cell, module, and installation level testing under UL 9540A must be used when applying a NFPA 68 solution. Where the likelihood for detonation exists, alternative solutions such as ~~those in NFPA 69~~ an automatic door opening system should be considered.

NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods:

1. Control of oxidant concentration
2. Control of combustible concentration
3. Pre-deflagration detection and control of ignition sources
4. Explosion suppression
5. Active isolation
6. Passive isolation
7. Deflagration pressure containment
8. Passive explosion suppression

Combustible gas concentration reduction can be a viable mitigation strategy for possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries. Gas detection and appropriate interlocks can be used based on appropriate evaluation under an NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL) 2 instrumented safety system rating.

Data on flammable gas composition and release rates, such as that included in UL 9540A fire and explosion testing, provide the information needed to design effective explosion control systems.

9.6.5.6.5~~4~~* (PI-75,339) Note reverses 9.6.5.6.4 and 9.6.5.6.5

Where approved, ESS ~~cabinets~~ shall be designed to ensure that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation level fire and explosion testing and an engineering evaluation performed by a registered design professional complying with 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control that complies with ~~NFPA 68 or~~ NFPA 69.

A.9.6.5.6.5~~4~~

Currently, UL 9540A includes a pass/fail criteria requiring that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected during the fire and explosion testing. Engineered solutions might be an effective solution to the deflagration hazard, and engineering details are to be submitted for review and evaluation by laboratory staff prior to testing.

Hazardous pressure wave guidance for human exposure and structure exposure can be found in NFPA 921 and in a City University of New York (CUNY) guidance document found at nysolarmap.com/media/2041/fire-safety-testing-data-analysis-supplement-for-nyc-outdoor-ess_v1.pdf. For human and structure exposure, a level less than 1 psig (6.9 kPa) might be indicated by the guidance material.

9.6.5.6.4~~5~~* (PI -76)

~~ESS enclosures and cabinets~~ Independent BESS cabinets installed in larger BESS configurations such as rooms, buildings or containers shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5 that includes the ESS ~~enclosure and~~ cabinets and the space they are installed within.

A.9.5.6.4 This condition effectively creates a "box in a box". Deflagration inside the smaller box can adversely impact the larger box and must be evaluated independently.

~~9.6.5.6.6*~~ (PI -77,341)

~~Where ESS batteries or cabinets are installed in a container outdoors, other than a walk-in unit, the installation shall comply with one of the following:~~

1. ~~The container shall be provided with explosion control complying with 9.6.5.6.3.~~
2. ~~Combination of the container and cabinets shall be tested together to show compliance with 9.6.5.6.1.1.~~

A.9.6.5.6.~~6~~7 (CI move to 9.6.5.6.7)

Possible standards to which gas detectors might be approved or listed include UL 2075 and FM 6325.

The purpose of the gas detector is to initiate ventilation that will remove flammable gases from the installation area before a flammable atmosphere is reached. Data from lithium-ion battery and module testing indicates that gas generation accelerates rapidly once the thermal runaway threshold is reached. Therefore, it is critical to initiate ventilation as early in the process as possible. Selection and location of the gas detector should be analyzed with the following considerations:

1. Detected gas
2. Response time
3. Ambient airflow
4. Vulnerability to fouling, poisoning, or drift
5. Required maintenance

Detected Gas. The detector should be selected to sense a gas that is likely to be present in the event of thermal runaway and in high enough quantities that the event will be identified in a timely manner. Note that while hydrogen is the primary combustible gas of concern for aqueous batteries (e.g., lead-acid, Ni-Cd, Ni-Zn), for lithium-ion batteries, multiple combustible gases are released in a thermal runaway/fire scenario. Hydrogen is usually the predominant gas generated, but significantly measurable quantities of methane, ethane, propylene, and ethylene are also produced along with trace amounts of other hydrocarbon combustible gasses (the actual mixture and percentages of combustible gases depends on the lithium-ion chemistry).

Response Time. The detector should be selected to minimize the response time to initiate ventilation. Factors that can impact response time include the distance for the air–gas mixture to travel to the detector, the length of the sample tube (if applicable), the type of detector, and the analysis process. Detectors can be listed with response times of under a minute to several minutes. Because gas generation is known to increase over the course of a thermal runaway event, the response time of the detector itself should be in the one to three minute range.

Ambient Airflow. There are several documents that provide qualitative guidance on the number and location of gas detectors in process areas (e.g., EN 60079-29-16-1), performance requirements of detectors for flammable gases (e.g., ISA TR84.00.07), and monitoring for hazardous material release (e.g., CCPS publication *Continuous Monitoring for Hazardous Material Releases*). These documents provide guidance on the most common approaches to gas detector placement, including target gas cloud and scenario-based monitoring.

The role of airflow, particularly in "open" ESS rooms and buildings, will greatly impact the location of detectors. Many LIB installations require constant ventilation to maintain batteries within the normal operating temperature range. In indoor installation areas, the airflow patterns will be determined by the mechanical ventilation system. In these cases, there will be an exhaust or recirculation duct where well-mixed air will come in contact with the gas detector. In smaller installations, or where multiple ventilation ducts are used, detector placement in the exhaust duct could provide the best chance for rapid detection. In large installations, this might not be the ideal or the only location for a gas detector due to the longer travel time for gas mixtures from the furthest unit to reach the duct. Additional detectors arranged in a grid pattern could be recommended.

Vulnerability to Fouling, Poisoning, and Drift. Note that not all combustible and toxic gas–sensing technologies are equal. Some are more sensitive than others to fouling (i.e., misreading and/or failure) from cross-contamination with other gases that might be present. Note that the largest quantities of gases produced during a lithium-ion fire are hydrogen, carbon monoxide, and carbon dioxide. The environment where the ESS is installed should be assessed to determine the likely presence of any other gases that could foul or poison a catalytic bead–type sensor or an electrochemical detector. The sampling tube size, where used, should consider particulate concentration in the ambient that could clog the tube if not maintained regularly. Some detectors must be "bump tested"—exposed to a small amount of the calibration gas—to ensure the sensor continues to sense the target gas at the desired concentration.

Required Maintenance. All detectors require routine maintenance to ensure continued proper function. The manufacturer's guidelines should be followed for regular calibration, bump testing (if needed), and sample tube cleaning. The recommended intervals for such maintenance vary from 1 to 12 months, depending on the type and manufacturer of the device. Designers and installers should ensure that end users are aware of the maintenance requirements and manufacturer's instructions. Calibration should only be conducted by qualified personnel, and only with the target gas.

9.6.5.6.7* (PI -79, 253,104,129 - FR)

Where gas detection is used to activate a combustible gas concentration reduction system (CGCRS) and based on an appropriate NFPA 69 deflagration study, BESS systems shall be protected by an approved continuous gas detection system that complies with the following:

1. The gas detection system shall be designed to activate the ~~combustible gas concentration reduction system~~ CGCRS on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
2. The ~~combustible gas concentration reduction system~~ CGCRS shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
3. The gas detection system and ~~combustible gas concentration reduction system~~ CGCRS shall be provided with EPSS or SEBSS per ~~s~~Section 4.10.

4. For lithium-ion batteries, the gas detection system and CGCRS EPSS or SEBSS shall be provided with a minimum of 24 hours of standby power while in a non-alarm condition and 2 hours of power in an alarm condition ~~or as required by the HMA~~.
5. The gas detection system and CGCRS status shall annunciate the following at ~~an approved central, proprietary, or remote~~ a supervising station as required by the AHJ to provide situation information to first responders in accordance with *NFPA 72*, or at an approved constantly attended location:
    1. ~~(a)~~ A trouble signal upon failure of the gas detection system or the combustible gas concentration reduction system.
    2. ~~(b)~~ An alarm signal if flammable gas concentration exceeds 10 percent of the LFL

9.6.5.6.7.1 Other technologies, besides gas detection, used for detection, notification, and initiation of the CGCRS shall be evaluated by a registered design professional with experience in fire protection per the HMA.

9.6.5.6.7.2 The HMA shall include an analysis to ensure survivability of the CGCRS up until fire occurs.

9.6.5.6.7.3 Where suppression systems other than water based are contained within an ESS, the detection, logic solvers and sequence of events for discharge shall not impede the CGCRS performance. An analysis of no impact shall be provided to the AHJ along with performance data.

9.6.5.6.7.2 CGCRS shall meet the test and inspection requirements of NFPA 69 Section 15.

9.6.5.6.8 **(PI 80 - FR)**

Compartmentalization created by cold and hot aisle arrangements within the ESS enclosure shall be addressed in accordance with the following:

1. For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment.
~~2. For NFPA 68 designs, the placement of explosion relief panels shall ensure that the explosion hazard is addressed for both hot and cold aisles/subcompartments.~~
~~3.~~2. The gas detection system shall be designed to activate on detection of flammable gas in either aisle/subcompartment.

9.6.5.6.9 (PI 78)

The protection design shall demonstrate that deflagrations are not propagated to interconnected ~~or adjacent cabinets, enclosures, or rooms~~BESS.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
Annex G	374		☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	Annex G should be revised to remove conflicts with requirements in the body of NFPA 855 and its referenced standards, and to correlate with current protection strategies in the standard. It should also remove content that duplicates, but differs slightly from requirements in the body of the standard.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The public input offers no specific modifications as such cannot be accept.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.2.3.3	47	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.2.3.3 The following similar hazards are present during abnormal operation, but should be considered more likely as a result of upset or damage: (1) *Corrosive spills*: A liquid with a pH ≤2 or ≥11.5 is considered corrosive and hazard level 3 and can cause serious or permanent eye injury for someone who comes in direct contact with it per Table B.1 in NFPA 704. With some systems that contain corrosive liquids, there can be the possibility of leaks or spills from the system under emergency/abnormal conditions. (2) *Toxic liquid exposure*: There are different levels of toxicity from vapors generated under emergency conditions such as fires and hazardous toxic liquid leaks and spills. NFPA and OSHA provide extensive guidance on classifying the hazards associated with toxic liquids and vapors. (3) *Water-reactive material exposure*: Water-reactive materials in ESS could be exposed under abnormal conditions, resulting in a violent reaction with the moisture in the air. (4) *Toxic gas exposure*: Toxic gases can be released during abnormal operation or following damage to an ESS. This may include toxic gases produced from the interaction of clean agent suppression systems with a battery fire. OSHA and NFPA 704 contain guidelines for classification of these hazards.		

	(5) *Toxic particulate exposure*: In addition to gases, some of the particulates produced in a battery fire may be toxic. (6) *Toxic metal exposure:* Toxic/heavy metals and/or metal oxides may be released during an abnormal event.
First Revision Text (FR)	G.2.3.3 The following similar hazards are present during abnormal operation, but should be considered more likely as a result of upset or damage: (1) *Corrosive spills*: A liquid with a pH ≤2 or ≥11.5 is considered corrosive and hazard level 3 and can cause serious or permanent eye injury for someone who comes in direct contact with it per Table B.1 in NFPA 704. With some systems that contain corrosive liquids, there can be the possibility of leaks or spills from the system under emergency/abnormal conditions. (2) *Toxic liquid exposure*: There are different levels of toxicity from vapors generated under emergency conditions such as fires and hazardous toxic liquid leaks and spills. NFPA and OSHA provide extensive guidance on classifying the hazards associated with toxic liquids and vapors. (3) *Water-reactive material exposure*: Water-reactive materials in ESS could be exposed under abnormal conditions, resulting in a violent reaction with the moisture in the air. (4) *Toxic gas exposure*: Toxic gases can be released during abnormal operation or following damage to an ESS. This may include toxic gases produced from the interaction of clean agent suppression systems with a battery fire. OSHA and NFPA 704 contain guidelines for classification of these hazards. (5) *Toxic particulate exposure*: In addition to gases, some of the particulates produced in a battery fire may be toxic. (6) *Toxic metal exposure:* Toxic/heavy metals and/or metal oxides may be released during an abnormal event.
Statement (technical reason for FR)	Information on the generation and emission of toxic gases is still limited. The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.3.1.1	59	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.3.1.1		

	The risk assessment design process should be directed by ~~parties~~ a registered design professional experienced in fire protection engineering and in energy storage risk assessment and plant operation of the type of, or similar to the, plant under consideration.
First Revision Text (FR)	G.3.1.1 The risk assessment design process should be directed by a registered design professional ~~parties~~ experienced in fire protection engineering and in energy storage risk assessment and plant operation of the type of, or similar to ~~the,~~the plant under consideration.
Statement (technical reason for FR)	The term "registered design professional" is used and required for evaluation of multiple required reports in the standard including an HMA. This guidance section needs to confirm RDP instead of qualified person.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.4.3.1.1.5	350	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	G.4.3.1.1.5 Water-Based Suppression System. Water-based suppression systems include sprinklers, sprayers, deluge systems, or water mist systems designed to suppress fire.		
First Revision Text (FR)	G.4.3.1.1.5 Water-Based Suppression System. Water-based suppression systems include sprinklers, sprayers, deluge systems, or water mist systems designed to suppress fire.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The public input didn’t include any outlined modifications therefore no modification can be made. The submitter should clarify with a public comment.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

G.6.1.1	373	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.6.1.1 Sprinklers. There are two known publicly available fire and explosion tests ~~, equivalent to UL 9540A,~~ supporting the use of ceiling-level sprinkler systems for the protection of LIB ESS. One test evaluated a 83 kWh system made up of lithium-iron-phosphate batteries and another evaluated a 125 kWh system made up of nickel-manganese-cobalt-oxide batteries. In both tests, protection was provided by ceiling sprinklers having a K-factor of 5.6 gpm/psi$^{1/2}$ operating at a discharge pressure of 2 bar (29 psi) to provide a nominal discharge density of 0.3 gpm/ft^{2}. The results show that fire and explosion testing is needed to determine the following: (1) Ceiling sprinkler protection can prevent or delay a fire from spreading beyond the ESS rack of origin, but obstructions caused by the design of ESS system (e.g., solid-metal cabinet encompassing tightly packed battery modules) limit the ability to suppress or extinguish fire within the rack of origin. (2) Minimum space separation has been provided from the ESS to surrounding combustibles to limit the potential for additional fire spread, including nearby ESS racks (3) Minimum space separation has been provided from the ESS to surrounding noncombustible objects to limit the potential for damage (4) If fire does spread to an adjacent ESS rack (i.e., installed side-by-side), it does not impact the design and electrical capacity of battery components as well as the design of the ESS cabinet that houses the battery components (e.g., battery modules) (5) Adequate cooling of the batteries is provided to prevent reignition, which can occur after a fire appears to be extinguished. A fire watch should be present until all potentially damaged ESS equipment containing Li-ion batteries is removed from the area following a fire event. (6) Adequate building component rating is provided to withstand the expected intensity and duration of an ESS fire event. The wide range of results highlight the need for fire and explosion testing to evaluate sprinkler protection for each unique ESS to ensure the expected level of protection is provided. Protection system considerations that would require a fire and explosion test include a reduction in the specified sprinkler system design density, a reduction in the minimum separation distance from nearby combustible and noncombustibles, changes in ESS cabinet, or increasing ESS electrical capacity.		
First Revision Text (FR)	G.6.1.1 Sprinklers. There are two known publicly available fire and explosion tests, ~~equivalent to UL 9540A,~~ supporting the use of ceiling-level sprinkler systems for the protection of LIB ESS. One test evaluated a 83 kWh system made up of lithium-iron-phosphate batteries and another evaluated a 125 kWh system made up of nickel-manganese-cobalt-oxide batteries. In both tests, protection was provided by ceiling sprinklers having a K-factor of 5.6 gpm/psi$^{1/2}$ operating at a discharge pressure of 2 bar (29 psi) to provide a nominal discharge density of 0.3 gpm/ft^{2}. The results show that fire and explosion testing is needed to determine the following: 1. Ceiling sprinkler protection can prevent or delay a fire from spreading beyond the ESS rack of origin, but obstructions caused by the design of		

	ESS system (e.g., solid-metal cabinet encompassing tightly packed battery modules) limit the ability to suppress or extinguish fire within the rack of origin. 2. Minimum space separation has been provided from the ESS to surrounding combustibles to limit the potential for additional fire spread, including nearby ESS racks 3. Minimum space separation has been provided from the ESS to surrounding noncombustible objects to limit the potential for damage 4. If fire does spread to an adjacent ESS rack (i.e., installed side-by-side), it does not impact the design and electrical capacity of battery components as well as the design of the ESS cabinet that houses the battery components (e.g., battery modules) 5. Adequate cooling of the batteries is provided to prevent reignition, which can occur after a fire appears to be extinguished. A fire watch should be present until all potentially damaged ESS equipment containing Li-ion batteries is removed from the area following a fire event. 6. Adequate building component rating is provided to withstand the expected intensity and duration of an ESS fire event. The wide range of results highlight the need for fire and explosion testing to evaluate sprinkler protection for each unique ESS to ensure the expected level of protection is provided. Protection system considerations that would require a fire and explosion test include a reduction in the specified sprinkler system design density, a reduction in the minimum separation distance from nearby combustible and noncombustibles, changes in ESS cabinet, or increasing ESS electrical capacity.
Statement (technical reason for FR)	Documentation has not been provided on these "two known publicly available fire and explosion tests" to demonstrate they are equivalent to UL 9540A. That reference should be deleted, which doesn't impact the overall points made in this section.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.6.1.3.2	353	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	G.6.1.3.2 Standards. For more information on water mist systems and Encapsulating Agents (EA), see NFPA 750 ~~adn~~and NFPA 18A respectfully.		
First Revision Text (FR)	G.6.1.3.2 Standards. For more information on water mist systems, see NFPA 750.		

Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Technical information and large--scale fire testing has not been submitted supporting the use NFPA 18A for LIB. Submitter should provide backup information during public comment stage.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.6.1.3.3	270	352	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	G.6.1.3.3 For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following: (1) DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression.” (2) Marioff Corporation – Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms.” (3) IFAB GmbH, Fraunhofer Heinrich-Hertz-Institut and FOGTEC Brandschutz GmbH, "White Paper - Fixed Firefighting Solutions for Stationary Energy Storage Systems (ESS)"		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The submitter needs to provide the documents during public comment stage for evaluation for inclusion as a reference.		
G.6.1.3.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	352	270	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	G.6.1.3.3 For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following:		

	(1) DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression.” (2) Marioff Corporation – Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms.” (3) NOISH- Comparison of Fire Suppression Techniques on Lithium Ion BatteryPack Fires
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	The submitter needs to provide the documents during public comment stage for evaluation for inclusion as a reference.
First Revision Text (FR)	G.6.1.3.3 Fire and Explosion Test Report References for Li-Ion Battery Fire Suppression with Water Mist. For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following: 1. DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression.” 2. Marioff Corporation – Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms.”

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New G.6.5	354	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	G.6.5 Encapsulation. ~~(Reserved)~~ NFPA 18A Standard on Water Additives for Fire Control and Vapor Mitigation Section A.4.3 states- Lithium-ion battery and lithium-ion battery energy storage system (BESS) fires are unique electrochemical fire hazards that involve multiple fire classes (Class A, Class B, Class C, Class D) within one entity. While BESS are covered by NFPA 855, it should be noted that lithium-ion battery fires as a stand-alone hazard are not currently addressed in any NFPA standard. According to NFPA research reports, copious amounts of plain water are required to extinguish lithium-ion battery fires, and they can still exhibit thermal runaway up to 72 hours after initial extinguishment. Water additive based on spherical micelle technology (encapsulator agents) conforming to Section 7.7 has been tested extensively by independent third-party testing organizations, including Kiwa, Dekra, Daimler, Dutech, Bosch, Fraunhofer University, and TU Clausthal. This testing has been controlled, scientific, and highly instrumented, documenting fire suppression, control and elimination of thermal runaway, and encapsulation of both flammable electrolyte and		

	other explosive off-gases, rendering them nonexplosive. Encapsulating technology reduces the toxicity of HF gas exposure to humans. In addition, the copious amounts of water used to suppress lithium-ion battery fires create copious amounts of run-off containing hydrofluoric acid, creating an environmental issue and expensive HAZMAT disposal cost. Compared to water, water additive solution uses a reasonable amount of solution and has been documented to modify the chemistry of the run-off, making it suitable for additional dilution and disposal in a municipal water treatment plant. Testing documentation can be found in the NFPA Research Library and Archives. This space should be reserved for futher clarifcatoin on the uses of micelle technolgies and its application in various systems, i.e. sprinkler system, water mist system, etc. in this standard during this revision cycle.
First Revision Text (FR)	To create a FR, revise text above or paste final version here.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Technical information and large-scale fire testing has not been submitted supporting the use NFPA 18A for LIB. Submitter should provide backup information during public comment stage.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.1	318	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.7.3.1 While not technically a detection system, a BMS can provide input into the fire system as a first-stage warning. A BMS can monitor fault conditions, abnormal voltages, and increase in heat—all potential precursors to LIB failure. The BMS, in conjunction with other detection technologies, can provide a better indication of the type of fire condition—either internal or external to the batteries. If the BMS is used to inform first responders it must be appropriately interfaced and information must be able to be reliably transmitted.		
First Revision Text (FR)	G.7.3.1 BMS. While not technically a detection system, a BMS can provide input into the fire system as a first-stage warning. A BMS can monitor fault conditions, abnormal voltages, and increase in heat—all potential precursors to LIB failure. The BMS, in conjunction with other detection technologies, can provide a better indication of the type of fire condition—either internal or external to the batteries. If the BMS is used to inform first responders, it must be appropriately interfaced and information must be able to be reliably transmitted.		

Statement (technical reason for FR)	There is increasing desire to deliver information to first responders from the BMS which often has more information about the SOC, cell temperature, and other potentially useful information. This note makes it clear that if BMS data is provided and relied upon that the mechanism must be reliable.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.2	320	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.7.3.2 Smoke Detection. Standard spot-type smoke detection is applicable to nonbattery fires and can detect conditions that can lead to a battery failure or thermal runaway event. In a battery failure, smoke ~~is~~ may be detected after thermal runaway ~~and is not applicable to early detection of LIB failures. Smoke detection can be applied at a cabinet level for a quicker response to an LIB failure~~ but may not be detected during the early stages of LIB failures. In general the smaller the LIB enclosure the quicker the response time of the detector. Spot-type smoke detection can be used as an interlock for fire suppression system release.		
First Revision Text (FR)	G.7.3.2 Smoke Detection. Standard spot-type smoke detection is applicable to nonbattery fires and can detect conditions that can lead to a battery failure or thermal runaway event. In a battery failure, smoke ~~is~~ may be detected after thermal runaway ~~and is not applicable to early detection of LIB failures. Smoke detection can be applied at a cabinet level for a quicker response to an LIB failure.~~ but may not be detected during the early stages of LIB failures. In general, the smaller the LIB enclosure the quicker the response time of the detector. Spot-type smoke detection can be used as an interlock for fire suppression system release.		
Statement (technical reason for FR)	This provides additional details on smoke detector response at various stages of an event.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

G.7.3.3	322	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.7.3.3 Flame Detection. Flame detection is a specific form of radiant energy detection and it may use imaging or non-imaging technology. Flames are ~~do~~ not present until after an LIB has gone into thermal runaway. Flame detection can be applied internal or external to an installation. Internal application would be to the container, enclosure, or building. It would not traditionally be applied inside a cabinet. For example, it can be used to monitor a hot isle. External application would be to ESS facilities with single or multiple containers. It would provide a detection if internal measures failed, however will not alarm until flame energy is released externally. It can also be tied to video cameras to provide situation information to first responders of an incident. Some flame detectors include HD video cameras and onboard recording capability.		
First Revision Text (FR)	G.7.3.3 Flame Detection. Flame detection is a specific form of radiant energy detection, and it may use imaging or non-imaging technology. Flames are ~~do~~ not present until after an LIB has gone into thermal runaway. Flame detection can be applied internal or external to an installation. Internal application would be to the container, enclosure, or building. It would not traditionally be applied inside a cabinet. For example, it can be used to monitor a hot isle. External application would be to ESS facilities with single or multiple containers. It would provide a detection if internal measures failed however will not alarm until flame energy is released externally. It can also be tied to video cameras to provide situation information to first responders of an incident. Some flame detectors include HD video cameras and onboard recording capability.		
Statement (technical reason for FR)	This provides additional information on flame detection related to LIB events		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.4	323	None	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	G.7.3.4 Heat Detection. Spot-type heat detection is applicable to nonbattery fires and can detect conditions that can lead to a battery failure or thermal runaway. In a battery failure, heat is detected after thermal runaway and is not applicable to early detection. Heat detection can be used as an interlock for fire suppression system release. The best use of heat detection is as a high-flow ESFR head attached to a dry stand-pipe or fire department connection to apply water to the building, area, container, or cabinet in LIB failure. Heat detection or temperature monitoring integral to the BMS can provide early indication of a battery failure prior to thermal runaway. Linear type heat detection has UL and FM approval and actively measures the temperature along the length of the fiber, is accurate to within 0.1°C, and may be installed on the ceiling, along power cable bundles and beside battery modules. This type of detection can provide early warning increase above a fixed temperature as well as fast rate of temperature rise indication and integrate with the BMS and fire alarm systems. These systems may supplement the online condition monitoring systems.
First Revision Text (FR)	G.7.3.4 Heat Detection. Spot-type heat detection is applicable to nonbattery fires and can detect conditions that can lead to a battery failure or thermal runaway. In a battery failure, heat is detected after thermal runaway and is not applicable to early detection. Heat detection can be used as an interlock for fire suppression system release. The best use of heat detection is as a high-flow ESFR head attached to a dry stand-pipe or fire department connection to apply water to the building, area, container, or cabinet in LIB failure. Heat detection or temperature monitoring integral to the BMS can provide early indication of a battery failure prior to thermal runaway. Linear type heat detection has UL and FM approval and actively measures the temperature along the length of the fiber, is accurate to within 0.1°C, and may be installed on the ceiling, along power cable bundles and beside battery modules. This type of detection can provide early warning increase above a fixed temperature as well as fast rate of temperature rise indication and integrate with the BMS and fire alarm systems. These systems may supplement the online condition monitoring systems.
Statement (technical reason for FR)	This provides additional information on heat detection and its potential use for detection of LIB fires
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.5	325	None	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)	G.7.3.5 Thermal Imaging—Temperature Monitoring and Early Warning Fire Detection. Thermal imaging is another form of radiant energy detection, and it might be applicable to early detection of overheating that may lead to fires including LIB failure. With proper placement, detectors are capable of detecting small changes in temperature associated with battery failure and early detection. It requires a line of ~~site~~ sight to the protected area and might ~~not function~~ require special lenses in a small container or cabinet. ~~It can provide the added benefit of visual images. It can~~ The thermal imager may be combined with a visual camera that can provide situational awareness. Thermal imaging can be used internal or external to the BESS. First responders can use the images to access the internal condition of the ESS. ~~7.3.5 Thermal Imaging—Temperature Monitoring and Early Warning Fire Detection.~~ Thermal imaging is another form of radiant energy detection and it might be applicable to early detection of overheating that may lead to fires including LIB failure. With proper placement, detectors are capable of detecting small changes in temperature associated with battery failure and early detection. It requires a line of ~~site~~ sight to the protected area and might ~~not function~~ require special lenses in a small container or cabinet. ~~It can provide the added benefit of visual images. It can~~ The thermal imager may be combined with a visual camera that can provide situational awareness. Thermal imaging can be used internal or external to the BESS. First responders can use the images to access the internal condition of the ESS. Thermal radiation is invisible electromagnetic radiation emitted by a body or object based on its surface temperature. Thermal imaging technology (i.e., thermal radiometry) makes it possible to view, record, and alarm on the slightest temperature anomalies, making it an effective solution in monitoring batteries during normal load or test. Fixed-mounted thermal cameras provide a predetermined field of view and continuous temperature monitoring as opposed to hand-held units requiring personnel time and potential for variation of readings and views. As a fixed unit, the camera tracks temperature and can provide graphical data over time that can be utilized in a preventative maintenance program and post-event evaluation of battery failures. Alarm relay outputs are available for monitoring by a PLC for equipment shutdown and annunciation. Thermal radiometry hand-held cameras are commonly carried by first responders into smoke-filled buildings, as the technology can see hot spots through the smoke. Along these lines, fixed thermal radiometry cameras in an ESS building with many racks will simplify first responders' evaluation of the fire size and location, providing situational awareness and lead them directly to the fire and away from potential danger, which minimizes their time in the hazard. Thermal radiometry cameras are available in wide to narrow field of view, various resolutions of image sensor pixel count, and software platforms. Care should be taken to ensure that the correct product is selected allowing the resolution required to accurately measure the required temperature variations at the specified distance. Camera software can provide live or recorded video, floating-crosshair indicating pixel(s) with highest or lowest temperature, various color schemes representing temperatures, email notification of alarm, as well as configuration of multiple areas of interest with unique temperature monitoring, alarm, and graphical information within a single camera image.
First Revision Text (FR)	G.7.3.5 Thermal Imaging—Temperature Monitoring and Early Warning Fire Detection. Thermal imaging is another form of radiant energy detection and it might be applicable to early detection of overheating that may lead to fires including ~~of~~ LIB failure. With proper placement, detectors are capable of detecting small changes in temperature associated with battery failure and early detection. It requires a

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Statement (technical reason for FR)	This provides additional information on thermal imaging and its potential use for detection of LIB fires
Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>G.7.3.6.1</td><td>327</td><td>None</td><td>☒ ~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">G.7.3.6.1 Cell-Level Event.

Battery cells will release flammable gases throughout the cell venting and thermal runaway stages of failure, however the species composition, release rate, and temperature will vary based on the phase. Ideally during cell venting, the battery's safety features are activated, leading to the release of gas and other reactive materials in a controlled manner to prevent an uncontrolled explosion. In this scenario, the gas species primarily consists of carbon dioxide (CO2), carbon monoxide (CO), hydrogen (H2) and VOCs. The gas temperature during cell venting is generally around 100-150°C.

During cell thermal runaway, the battery undergoes a rapid, self-sustaining increase in temperature. In this situation, additional flammable and toxic gas species may be produced including hydrogen fluoride (HF), hydrogen cyanide (HCN), various hydrocarbon gases (CH4, C2H4, C2H6, etc.), in addition to those gases produced during cell venting. The gas temperature during thermal runaway can reach much higher levels, often exceeding 500°C, resulting in the rapid release of large volumes of flammable and/or toxic gases, posing a significant hazard to human health and the environment.

Off-gas detection in the early stages may target different gas species than that during cell thermal runaway. In all cases the detection method should be tied to the cell chemistry, sensor location relative to the cell(s), volume of the enclosure (ie a cabinet or a large room), and objective of detection in order to ensure that the sensor is aligned with the safety objectives. Technologies are advancing rapidly however early and rapid detection must also be paired with response, thus costly systems that may provide some level of advanced notice may not provide a significant increase in actions or improved safety outcomes. In contrast to smoke detectors in occupied structures, knowledge of a cell failure several minutes earlier, may not result in any difference in outcome unless the detection system is also tied into a viable thermal runaway protection system which stops the event.

Off-gas detection systems of various types have been shown to be effective at detecting cell failure prior to thermal runaway, in some cases as much as 30 minutes prior, however this advanced knowledge must be tied into other mitigation systems in order to prevent thermal runaway from occurring or propagating.

Off-gas sensors or detectors are typically mounted in each battery rack or module, with the exact location of the sensors or detectors being dictated by the actual rack design. But, in general, the sensors must be mounted in the path of airflow. This could mean that, depending upon rack design, the sensor or detector could be either at the top or bottom of the rack. For specific detection design requirements, refer to the manufacturer’s published installation and operation manuals and any relevant regulatory approvals/listings for the intended purpose of “off-gas detection” from the incipient stages of a lithium-ion battery thermal runaway.

~~To~~ Presently, to be most effective, the network of sensors or detectors throughout the many battery racks in the ESS must be connected with a central controller that allows for the supervision for failures of the individual sensors and a coordinated response when one or more sensors or detectors detect an off-gas event. The responses can be either automated or human generated.</td></tr>
</table>

First Revision Text (FR)	G.7.3.6.1 Cell-Level Event. Battery cells will release flammable gases throughout the cell venting and thermal runaway stages of failure, however the species composition, release rate, and temperature will vary based on the phase. Ideally during cell venting, the battery's safety features are activated, leading to the release of gas and other reactive materials in a controlled manner to prevent an uncontrolled explosion. In this scenario, the gas species primarily consists of carbon dioxide (CO2), carbon monoxide (CO), hydrogen (H2) and VOCs. The gas temperature during cell venting is generally around 100-150°C. During cell thermal runaway, the battery undergoes a rapid, self-sustaining increase in temperature. In this situation, additional flammable and toxic gas species may be produced including hydrogen fluoride (HF), hydrogen cyanide (HCN), various hydrocarbon gases (CH4, C2H4, C2H6, etc.), in addition to those gases produced during cell venting. The gas temperature during thermal runaway can reach much higher levels, often exceeding 500°C, resulting in the rapid release of large volumes of flammable and/or toxic gases, posing a significant hazard to human health and the environment. Off-gas detection in the early stages may target different gas species than that during cell thermal runaway. In all cases the detection method should be tied to the cell chemistry, sensor location relative to the cell(s), volume of the enclosure (ie a cabinet or a large room), and objective of detection in order to ensure that the sensor is aligned with the safety objectives. Technologies are advancing rapidly however early and rapid detection must also be paired with response, thus costly systems that may provide some level of advanced notice may not provide a significant increase in actions or improved safety outcomes. In contrast to smoke detectors in occupied structures, knowledge of a cell failure several minutes earlier, may not result in any difference in outcome unless the detection system is also tied into a viable thermal runaway protection system which stops the event. Off-gas detection systems of various types have been shown to be effective at detecting cell failure prior to thermal runaway, in some cases as much as 30 minutes prior, however this advanced knowledge must be tied into other mitigation systems in order to prevent thermal runaway from occurring or propagating. Off-gas sensors or detectors are typically mounted in each battery rack or module, with the exact location of the sensors or detectors being dictated by the actual rack design. But, in general, the sensors must be mounted in the path of airflow. This could mean that, depending upon rack design, the sensor or detector could be either at the top or bottom of the rack. For specific detection design requirements, refer to the manufacturer’s published installation and operation manuals and any relevant regulatory approvals/listings for the intended

	purpose of “off-gas detection” from the incipient stages of a lithium-ion battery thermal runaway. Presently, to be most effective, the network of sensors or detectors throughout the many battery racks in the ESS must be connected with a central controller that allows for the supervision for failures of the individual sensors and a coordinated response when one or more sensors or detectors detect an off-gas event. The responses can be either automated or human generated.
Statement (technical reason for FR)	This provides additional details on cell level gas detection and the methods that may be best suited
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.6.3	132	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.7.3.6.3 Effects on H_2 Gas Detection After Suppression Discharge. Hydrogen is a ~~significate~~ significant ~~significate~~ percentage of the gases released during thermal runaway of an LIB. Traditional gas detection technology for detection of H_2 is a catalytic bead. A catalytic bead burns the gases across the sensor to determine concentration level or LFL. LIBs also release other HCs during failure. These other HCs will be burned on the sensor and recognized as H_2. A catalytic sensor will not perform well in a low-oxygen or suppression environment as the sensor’s ability to burn the gases will be limited. The sensors might fail or underreport the percentage of LFL. Other technology exists for detection of H_2 but can be overwhelmed and fail in a high H_2 release. In conjunction with a suppression system, a secondary sensor monitoring CO or CO_2 might be necessary to monitor as a reference gas. It is seen that for overheating and overcharging, CO is the most continuously present gas and thus provides a good indication of the full spectrum of gas profiles that can be expected. A similar profile can be found by monitoring CO_2. Rising levels of CO or CO_2 indicate a battery failure or cascading event. Gas release data should be utilized from the fire and explosion testing at a cell, module, and installation level for evaluation of appropriate gas detection. Cell to module to installation is not always a linear progression; meaning scaling up the test results might not give you an actual gas release. These conditions can change due to additional construction material and incorporated barriers. Installation testing can show more or less propagation than cell- or module-level tests.		
First Revision Text (FR)	G.7.3.6.3 Effects on H2 Gas Detection After Suppression Discharge. Hydrogen is a significant ~~significate~~ percentage of the gases released during thermal runaway of an LIB. Traditional gas detection technology for detection of H2 is a catalytic bead. A catalytic bead burns the gases across the sensor to		

	determine concentration level or LFL. LIBs also release other HCs during failure. These other HCs will be burned on the sensor and recognized as H2. A catalytic sensor will not perform well in a low-oxygen or suppression environment as the sensor's ability to burn the gases will be limited. The sensors might fail or underreport the percentage of LFL. Other technology exists for detection of H2 but can be overwhelmed and fail in a high H2 release. In conjunction with a suppression system, a secondary sensor monitoring CO or CO2 might be necessary to monitor as a reference gas. It is seen that for overheating and overcharging, CO is the most continuously present gas and thus provides a good indication of the full spectrum of gas profiles that can be expected. A similar profile can be found by monitoring CO2. Rising levels of CO or CO2 indicate a battery failure or cascading event. Gas release data should be utilized from the fire and explosion testing at a cell, module, and installation level for evaluation of appropriate gas detection. Cell to module to installation is not always a linear progression; meaning scaling up the test results might not give you an actual gas release. These conditions can change due to additional construction material and incorporated barriers. Installation testing can show more or less propagation than cell- or module-level tests.
Statement (technical reason for FR)	This is a spelling correction.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.7.3.7.2	50	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.7.3.7.2 High-Risk Equipment Protection. Certain equipment in ESS facilities are designated high-risk. The consequences of a fire event within such equipment could create or exacerbate other hazards. Examples of these types of equipment include the following: (1) Those that are likely to promote a fast developing fire. (2) Those that will generate corrosive and toxic ~~gas species~~ and highly toxic emissions. (3) Those whose unnecessary shutdown would result in substantial network service losses. (4) System losses that could create conditions for battery failure such as HVAC or BMS system loss.		

	Sampling location considerations are often similar to those for cabinet protection and include the following: (1) Sampling should be conducted within or around high-risk equipment for the earliest possible detection of smoke. (2) Where appropriate and within the system design capacity, capillary tubes branched from the main sampling pipe can be used to penetrate equipment or equipment cabinets. Normally, dedicated systems should be used unless in small rooms. (3) All sampling pipes should be airtight, firmly secured, and held clear of equipment, especially moving parts, to avoid physical damage to the pipe network or the equipment.
First Revision Text (FR)	G.7.3.7.2 High-Risk Equipment Protection. Certain equipment in ESS facilities are designated high-risk. The consequences of a fire event within such equipment could create or exacerbate other hazards. Examples of these types of equipment include the following: 1. Those that are likely to promote a fast developing fire. 2. Those that will generate corrosive and toxic and highly toxic emissions ~~gas species~~. 3. Those whose unnecessary shutdown would result in substantial network service losses. 4. System losses that could create conditions for battery failure such as HVAC or BMS system loss. Sampling location considerations are often similar to those for cabinet protection and include the following: 1. Sampling should be conducted within or around high-risk equipment for the earliest possible detection of smoke. 2. Where appropriate and within the system design capacity, capillary tubes branched from the main sampling pipe can be used to penetrate equipment or equipment cabinets. Normally, dedicated systems should be used unless in small rooms. 3. All sampling pipes should be airtight, firmly secured, and held clear of equipment, especially moving parts, to avoid physical damage to the pipe network or the equipment.
Statement (technical reason for FR)	The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

New G.8	64	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	See below for proposed new text.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	This addition provides necessary information to the industry for guidance on how to evaluate the explosion control as required under Section 9.6.5.6.		
Response (technical reason for not making some changes or for resolving)			
First Revision Text (FR)			

G.8 ~~Reserved~~ Explosion Hazard Analysis and Mitigation for Lithium Ion ESS

G.8.1 Introduction

This section assists authorities having jurisdiction (AHJs), stakeholders, and practitioners with engineering design and risk mitigation considerations to minimize the likelihood and consequences of an explosion event. This section does not prescribe how hazard and risk analyses are performed, rather to present principles and methodologies to assist the energy storage practitioner in the qualitative and quantitative analysis process.

G.8.2 Essential Hazard Mitigation Analysis (HMA) Elements

G.8.2.1 Probability and Consequence

In the design of these systems, engineers must balance criteria for performance, cost, size, and safety concerns. Achieving a high level of safety is especially important in applications in densely populated environments, such as indoor installations, where a thermal-runaway event is more likely to lead to harm occupants or result in high losses of the structure and property.

Typically, explosion risk is quantified by assessing probability of occurrence, consequences of the event, and detectability of the generation of flammable gases of an event. Although the probability of an explosion is low in compliant listed and labeled BESS, the effects and consequences can be extremely high. The first key feature of a HMA is the identification and quantification of the explosive risks associated with the BESS design.

Explosions can occur wherever flammable gas is able to accumulate within its flammability limits in an enclosure. For an ESS, this may occur within a single rack enclosure, standalone enclosure, installation structure, or building. For more input on design scenarios, below.

Each Lithium-ion battery chemistry present unique explosive risks due to the complex nature of their failure mechanisms: they produce large volumes of flammable gases and produce sufficient oxygen to sustain exothermic reactions can emit particles hot enough to ignite gases.

A comprehensive HMA should include an assessment of explosive risks of the ESS unit as well as the overall installation with site specific considerations of exposures, property safety, and life safety.

Each HMA should consider the integrated benefits of the purposeful layering of complementary engineering and administrative controls hierarchy thereby building defense in depth controls to establish a mitigated consequence probability.

G.8.2.2 Hierarchy of Controls

With each identified hazard quantified, the mitigation objectives and associated approaches can then be considered based on acceptable risk tolerance, feasibility, and the hierarchy of controls. Within the hierarchy of controls, explosion hazards may be managed by engineering controls and administrative controls.

Engineering controls should focus on the reducing or eliminating the generation of combustible gas, reducing the accumulation or concentration of combustible gas, and managing consequences of a deflagration with structural design and appropriate siting to exposures) and administrative controls. Some available explosion risk mitigation strategies include flammable gas exhaust, deflagration venting, inerting, suppression, hardening, and increased standoff distance to personnel and assets.

Administrative controls may include the proceduralization of operator instructions enabling early detection and purposeful de-energization of systems exhibiting degraded performance, increasing the breadth and depth of the scheduling of routine periodic maintenance focusing on safety critical system performance, implementation of daily operator status of health checks, or any other purposeful operator interaction with the systems to increase visibility and early detection of abnormal system performance.

G.8.3 Engineering Controls Considerations

G.8.3.1 Reducing the Probability of Combustible Gas Generation

Detection and preventing the generation of combustible gas within BESS should be the objective of all engineered energy storage systems.

The careful selection of the Lithium-ion battery chemistry should be researched, considering cell failure propensity where the generation of combustible gas may require additional and costly mitigation measures.

Reliance on industry certifications for safe operations of OEM battery management systems (BMS) and thermal management systems has proven to not prevent thermal runaway events. Additional design considerations of the ESMS or critical safety control systems should include the ability to monitor state-of-health and performance of individual cells (voltage, current, temperature) and take compensatory measures to reduce overcharge, over-discharge, and over-temperature conditions resulting in the removal of the affected module or rack from service.

Once deenergized, additional administrative controls may be implemented and may include any verification measure including corrective maintenance and removal from service.

G.8.3.2 Preventing or Reducing the Probability of Combustible Gas Accumulation

The explosion potential can be eliminated or reduced by preventing the accumulation of combustible gas within the installation or product enclosure.

To reduce flammable gas accumulation at the installation, a well-designed combustible gas reduction (ventilation) system must be incorporated. Design trends within the energy storage market sector include several different and competing design philosophies. These designs range from containing the battery modules and off-gas in gas-tight enclosures leading directly to a safe area, without passing the battery room. Other approaches include opening battery rack enclosures to the battery compartment where off-gas can be diffused by a forced exhaust system of sufficient air changes per hours (ACH). Forced exhaust systems are typically designed in accordance with NFPA 69. Opening the access doors to the enclosure and flooding the container with environment thereby exposing the battery compartment directly to external environment is another method to meet the NFPA 855 explosion prevention and deflagration venting requirements.

G.8.3.3 Managing the Consequences of Deflagrations or Explosions

A comprehensive ESS explosion hazard mitigation includes the purposeful management of the consequences of deflagration or explosion through the implementation of deflagration protection (NFPA 68) or explosion prevention (NFPA 69).

Each BESS equipment provider should conduct an explosion hazard analysis to quantify the risks (explosive pressures, direction, missile generation and projection, heat flux, fireball, etc.) and hazards (personnel, equipment, and environmental safety) and validate proposed mitigation designs. The proposed mitigative designs should objectively demonstrate conservative and bounding scenarios where the engineering controls mitigate the hazards. These mitigation analyses can be in the form of maximum theoretical steady-state analysis or computations fluid dynamics (CFD) modeling.

When reviewing the computational fluid dynamics or other analyses performed, the designer, functional safety engineer, practitioner, and AHJ should consider other important elements are presented in the explosion hazard analysis: enclosure reaction force; enclosure geometry; enclosure internal surface area including partial volumes; surface area of internal structures; flammable gas properties including lower flammability limit (LFL), laminar flame speed, and maximum closed vessel deflagration pressure.

G.8.4 Engineering Controls and Practices for Explosion Hazard Mitigation

G.8.4.1 Design Considerations

The broad range of recent global energy storage market sector failures and fires require the functional safety engineer to consider multiple credible and probabilistic scenarios as part of the

HMA. Probabilistic scenarios should include the relevant data generated in the UL 9540A cell and module test as a realistic option for failure resulting in fire or explosions. Analysis should also include common-cause or common mode failures that also include plausible scenarios where ignition sources may be evident. Conservatism should always be applied to ensure a safety margin.

G.8.4.1.1

Recommended failure scenarios to consider in an HMA include:

1) UL 9540A failure level: One or more cells, module, or unit based on the test results. UL 9540A is designed to induce cell-to-cell propagation of thermal runaway and measure the resultant fire and explosion hazards.

2) Limited propagation failure. Adds a safety margin to the UL 9540A test result. For example, if one cell failed with no propagation, then evaluate a 3-cell failure, one on either side. If a module failed but did not propagate, then evaluate a 3-module failure, one above and below.

3) 25% LFL failure: Determine how may cells it takes to reach 25% LFL in the enclosure. This may overlap with another design scenario.

4) Partial volume deflagration: Determine how many cells can fail with a resulting deflagration that does not produce a pressure value that will cause the enclosure to fail.

5) Worst total failure: Assume all cells in the ESS fail.

G.8.4.2 Combustible Gas Venting Pathway

If the lithium battery releases gas under pressure, there are a number of determining factors that influence the release rates and initial geometry of the escaping gases. The pressurized gas is released as a gas jet and depending on the nature of the failure, may be directed by the module cooling system exhaust pathway. Escaping gases are normally very turbulent and air will immediately be drawn into the mixture. The mixing of air will also reduce the velocity of the escaping gas jet. Obstacles such as the module racking system, cable trays, conduit, HVAC ducting, buswork, structures, etc., will disrupt momentum forces of any pressurized release thereby adversely impacting turbulent nurning velocities.

BESS designs that include obstructions (conduit and piping arrays, internal obstructions) within the combustible gas venting pathway can have a significant impact on flame speed and enclosure pressures due to the turbulence generated during the flow of unburned gas over and around the obstacles. In the likely event of igniting of the combustible gas, the flame front surface area is increased as a function of the obstacle surface area resulting in increased pressure transients.

If the release of combustible gas is not detected or ignited, the gas will generally form a vapor cloud that will be distributed throughout the BESS enclosure through mechanical ventilation or would naturally disperse in the atmosphere. Once the combustible gas reaches the flammability limits and is exposed to an ignition source, an explosive blast will occur. The resultant turbulent dispersion processes will be prevalent (e.g., high pressure flow, winds, congestion, etc.) the gas will spread in both horizontal and vertical dimensions while continually mixing with available oxygen in the air. Initially, escaping gases are above the UEL, but with dispersion and turbulence effects, they will rapidly pass into the flammable range. If not ignited and given an adequate distance for dilution by the environment, they will eventually disperse below the LEL. Various computer software programs are currently available that can calculate the turbulent gaseous jet dispersion, downwind explosive atmospheric locations, and volumes for any given combustible commodity, release rates, and atmospheric date input (i.e., wind direction and speed).

G.8.4.3 Combustible Gas Reduction System.

To design a combustible gas reduction system, the properties of the combustible gas must be known or assumed. The major components of a lithium-ion battery gas thermal runaway are typically hydrogen, carbon monoxide, carbon dioxide, and various hydrocarbons. While lithium-ion battery failures may result in differing gas compositions based on state of charge (SOC), gas release quantity is higher and flammability properties are more severe as SOC increases. Battery thermal runaway gas composition is characterized experimentally for 100% SOC under the cell level test method of UL 9540A. This characterization includes test data for gas volume, gas composition, LFL, maximum burning velocity, and maximum closed vessel deflagration pressure.

G.8.4.4 Deflagration Venting and Application of NFPA 68 Considerations

Explosion venting is purposeful discharge of pressures generated from combustion gases during a deflagration to maintain pressures below the enclosure damage threshold of a structure. The engineered discharge vent opening is typically achieved by one or more transient pressure relieving panels, rupture discs, or other engineered vent devices. The most effective explosion venting systems are those that deploy early in the deflagration, have as large a vent area as possible, and allow unrestricted venting of combustion gases. Early vent deployment requires the vent be released at the lowest possible pressure without interfering with normal operations and pressure fluctuations in the enclosure. In the case of vents on exterior walls and roofs of buildings, the minimum feasible vent release pressure is usually slightly larger than the highest expected differential pressure associated with wind loads (typically 0.14 to 0.21 psig (0.96 to 1.44 kPa)).

Crucial aspects of vented-gas-explosion data correlations (obtained from the UL 9540A Cell and Module Level Test Reports) are mixture reactivity, turbulence sources (both initial turbulence and obstacle-flame interaction turbulence velocities), vessel volume (scale) effects, and vessel geometry (primarily length/diameter ratio), as well as the vent parameters: vent area, vent release pressure, and vent panel inertia. All aspects of these parameters should be made available to both the Fire Protection Engineer of Record and the AHJ.

The amount of vent area needed for effective explosion venting depends on the size of the enclosure and the rate of pressure rise within it. According to Equation 6.1.1 of NFPA 68, the rate of pressure rise in an unvented enclosure is proportional to the product of the mixture effective burning velocity and flame surface area and varies inversely with the enclosure volume.

NFPA 68 provides the recognized guidance for the design, location, installation, maintenance, and use of devices and systems that vent combustion gases and pressures resulting from a deflagration within an enclosure. However, it is noted NFPA 68 does not apply to emergency vents for pressure generated during runaway exothermic reactions, self-decomposition reactions, internal vapor generation resulting from electrical faults, or pressure generation mechanisms other than deflagration.

The process for calculating the surface area for deflagration venting is presented in NFPA 68 and the parameters to accomplish this analysis include protection volume, enclosure strength, reaction forces to counteract vent dynamics, enclosure geometry, enclosure internal surface area, gas fuel properties, flame enhancement, panel inertia, and partial volume deflagration considerations. Determination of each of these inputs should be documented by the HMA.

Large-scale testing may be used to demonstrate the effectiveness of vent areas and design approaches. Large-scale testing may demonstrate resultant damage of vent areas reduced from those specified in within NFPA 68, Chapters 7 and 8. An AHJ may then assess that damage is acceptable for an installation location and type.

Comprehensive assessment of resultant hazards for placement of deflagration venting systems also include fireball size determination in addition to enclosure pressure rise and rupture risk.

G.8.4.5 Combustible Gas Reduction Systems and the Application of NFPA 69 Considerations

The recognized national consensus standard to be used for the design and construction of explosion prevention systems is NFPA 69 and should be used in conjunction with this guidance to design combustible gas concentration reduction systems.

All components involved with the detection and ventilation of the combustible gas reduction system are considered part of a critical safety system and are subject to the normative requirements of State Codes and applicable sections of NFPA 69.

For effective and efficient mitigation of explosions within energy storage systems, the intentional use of the container ventilation system as a safety barrier to limit or control flammability limits, the following measures can be considered:

1) External ventilation at nominal rate in case of absence of carbon monoxide (to be measured by local CO detector).

2) Increase of external ventilation rate to 400 Nm3/h (or more) in case of combustible gas or CO detection in the container. The high CO content of the combustible gases generated during thermal runaway of batteries allows a rapid detection based on CO concentration.

3) Independent auxiliary power supply to the external ventilation system (fan and louvers, to avoid common mode failures in case of fire in the container).

However, it is understood the ESS thermal management system for internal container environmental control does not directly control or impact cell thermal runaway of one or more degraded cells. In the event of such a fire, the intentional operation of the ESS ventilation system may increase the combustion of the combustible gases by the introduction of fresh air into the container. Conversely, the introduction of fresh air may assist in diluting the combustible gases from reaching the LFL. Therefore, as part of the engineering controls and analysis for mitigating an explosive environment, stakeholders and practitioners should consider adopting a well evaluated risk-reduction and hazard mitigation strategy. This risk-reduction and hazard mitigation strategy should consider the appropriate variables and controls necessary to establish fire scenario metrics, energy storage management system performance permissives, and other administrative controls to determine the appropriate measures of when to stop/de-energize the ventilation in case of a confirmed container compartment fire.

Depending on the complexity of the ESS it is recommended a steady-state numerical or computational fluid dynamics (CFD) analysis be performed whereby multivariable attribute analysis can be performed to assist in the engineering risk reduction decision process. Each methodology has the strengths and weaknesses that should be carefully considered when evaluating mitigative measures.

In all modeling and analysis methodologies used, it is recommended that NFPA 69 be relied upon for verification and validation by the Fire Protection Engineer of Record of conclusions and results. The most common use of NFPA 69 for ESS facilities is presented in Chapter 8, Deflagration Prevention by Combustible Concentration Reduction. Chapter 8 outlines the requirements and techniques for maintaining the combustible gas concentration below the LFL.

NFPA 69 Section 8.2.3.2 requires ESS facility owner or operator to provide complete documentation and a detailed description of the protection system to be used for monitoring and controlling combustible gas concentrations. This system usually includes the following components:

1) Battery management system (BMS) provisions for detecting and controlling incipient cell anomalies that could lead to a thermal runaway.

2) Gas detection provisions designed to sense concentrations of various thermal runaway combustible gases produced in the early stages of a runaway and send an alarm to the BMS and external system monitors.

3) Normal and emergency ventilation and ESS enclosure exhaust components and provisions designed to dilute and expel combustible vapors including the ventilation control, air handler, louvers, etc.

NFPA 69 Section 8.2.3.4 requires the protection system design be reviewed by a qualified person acceptable to the facility's AHJ (typically the Fire Protection Engineer of Record). Other paragraphs require the ESS owner or operator to provide maintenance of the system after installation and acceptance, and to arrange for periodic inspection by personnel trained by the protection system manufacturer(s).

There is one important commonly overlooked requirement in NFPA 69 applicable to an instrumented explosion prevention control system, also known as a safety instrumented system (SIS) In order to achieve a minimum documented level of system reliability, Section 15.5.5 requires an SIS (installed after November 5, 2021) to be either listed for explosion prevention service or evaluated to demonstrate a safety integrity level (SIL) 2 rating in accordance with ANSI/ISA 84.000.01 (or IEC 61511 and IEC 61508, or approved equivalent functional safety standards). Demonstrated compliance in the determination of SIL 2 is to be conducted by a certified Functional

Safety Professional. Therefore, the review of all ESS instrumented explosion prevention systems should include a careful assessment of component and system reliability.

NFPA 69, Section 8.3.1 and NFPA 855, Section 9.6.5.6 requires the combustible gas concentration to be maintained at or below 25 percent of the LFL. This can be achieved by implementing the requirements of NFPA 855, Section 9.6.5.6.7(1) where the combustible gas concentration reduction system detection is activated when combustible gas concentrations reach 10% LFL.

If the combustible gas concentration reduction system includes safety interlocks, there is a provision in NFPA 69, Section 8.3.1 where systems are allowed to maintain combustible gas concentrations at or below 60 percent of the LFL. This is an important provision for BESS combustible gas reduction systems are shown to have reliable continuous monitoring of incipient thermal runaway combustible gases, though monitoring of thermal runaway gases may be challenged by the complexity of gas mixture and potential cross-sensitivity of measurement technologies.

NFPA 69 Section 8.3.3 contains requirements for ventilation and air intake and exhausts. These requirements include locating air intakes and exhausts such that combustible gas discharged from one enclosure will not enter the air intake of an adjacent enclosure.

NFPA 69 Annex D describes ventilation calculation methods to estimate the concentration of a combustible gas released into a ventilated enclosure such as a BESS container. Equations are given for simple applications including calculating the number of enclosure air changes per minute required to limit the average gas concentration to some fraction of the LFL. These equations are special case solutions to the following equation for gas concentration, C, as a function of time, t:

$G = V\, dC/dt + QC$ Equation 1

where:

V = enclosure volume

Q = enclosure ventilation rate

G = gas volumetric release rate

In order to account for ventilation mixing issues, i.e. non-uniform concentrations, the value of Q in Equation 1 is replaced by KQ, where K is an empirically determined mixing efficiency factor for the specific ventilation arrangement.

Other factors to be considered in the design of the combustible gas reduction system are presented in NFPA 69, Section 6.3 and include the reliability of this safety critical system. Safety critical reliability factors to be included in its design are presented in NFPA 69, Section 6.3.1. Recent industry experience has demonstrated the importance of the purposeful evaluation of the possibility of electrical and mechanical malfunctions as part of the overall system reliability determination. ESS system that relies upon auxiliary power systems should evaluate probability of the mean-time-between-failures (MTBF) of electrical supply for the energization and control of SIS critical safety systems within an ESS for project specific emergency operating conditions for the duration of primary and potentially secondary thermal runaway events. Auxiliary or standby power systems designed in accordance with NFPA 110 or NFPA 110 should be at a minimum Type 10 and should provide auxiliary power to those critical safety systems for the anticipated duration of the fault condition.

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>G.11.3</td><td>61</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">G.11.3 Guidelines.
Battery ESS based on electrochemical technologies represent the majority of ESS being designed and installed. The safe operation of electrochemical ESS is critical—especially when installed inside occupied structures. The primary concerns of the fire service with this type of installation would include the implications of overheating via internal or external heat source, thermal runaway, potential deflagration event in enclosed spaces, and the effective operation of fire detection, suppression, and smoke exhaust systems. There are additional concerns to be considered where assessing firefighter responses to electrochemical ESS.
Handover procedures for potentially damaged systems should be developed for fire departments to ensure the timely response of a qualified person as a technical representatives to manage safety issues. These procedures would also cover issues such as the removal or recycling of damaged equipment. Another procedural component is the realization that damaged ESS system components could include significant stored or stranded energy with no known method for safe dissipation. Stored or stranded energy could be defined as energy that remains in a battery after the system has been shut down.</td></tr>
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Statement (technical reason for FR)	"Qualified" is used in different configurations thru out the standard. This updates the usage to be consistently applied throughout the standard.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.11.4	62	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.11.4 Suppression Systems. Some ESS design validations have included pre-engineered inert or clean-agent fire suppression systems for fire protection. These system installations were often approved without validation based on fire and explosion testing in accordance with 9.1.5 by nationally recognized testing laboratories. Evidence-based data is needed to ensure ESS designers specify appropriate fire protection systems based on the material involved and physical design characteristics. Several early research papers from multiple organizations, including NFPA's Fire Protection Research Foundation, and third-party engineering groups have shown that fires involving lithium-ion cells must be cooled to terminate the thermal runaway process. Water is the agent of choice, yet system cabinet design could pose a significant barrier to the efficient application of water while simultaneously allowing the free movement of fire and combustion gases. One of the more challenging types of incidents will be one where no signs of overheating are visible, and no information is available via integral displays. This places the responding firefighter in the challenging position of determining what is safe or not with very little information. Integrated energy management systems (EMS) are designed to monitor and manage critical safety parameters of the battery such as cell temperature, voltage, and available current. While this data might prove valuable to responders to best understand the current state of the battery, there is no standard for manufacturers to provide a user interface to access the state of these parameters or a method to interface with to monitored alarm systems within the building. Responders should attempt to gather any visible information prior to shutting down the system unless there is clear evidence of imminent danger. Additionally, the response of a qualified ~~and trained individual in~~ person in ESS should be made available to assist the firefighters in the event of damage to an installed system.		
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Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.11.5	51	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.11.5 Overheated Batteries. The process of charging/discharging results in heat dissipation from cells. An optimum overall system design should include cascading layers of hardware and software protection, including at the battery cell, module or pod, and rack levels. Should a fault occur and over-heating of a cell continues, damage could occur resulting in swelling, off-gassing, fire, or explosion. Proper response to an overheated battery is needed. Fires in electrochemical ESS are often a result of a failure mode called *thermal runaway.* Thermal runaway can simply be defined as the process in which a battery creates heat within an individual cell but cannot dissipate that heat, resulting in dynamic temperature increase. Initial signs of thermal runaway might include pressure increase at the cell level, temperature increase, and off-gassing. As the process continues, additional signs might include vent gas ignition, exploding cells, projectile release, heat propagation, and flame propagation.		

	As the failure cascades, responders should also be prepared for toxic and highly toxic emission and potentially explosive gas release. Though fire and explosion testing in accordance with 9.5.3.2 to determine battery burn outcomes remains incomplete, including toxic and highly toxic emissions ~~gas release~~ calculations responders should treat them as highly dangerous ECE hazardous materials and use their full suite of PPE and breathing apparatus when responding. Proper response to electrochemical ESS fires should include the following procedures and steps: (1) System isolation and shutdown (2) Hazard confinement and exposure protection (3) Fire suppression (4) Controlled ventilation
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Statement (technical reason for FR)	The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. The annex is updated to reflect these requirements.

Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.11.7.3	63	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	G.11.7.3 Suppression Tactics. As previously mentioned, battery components are often housed in cabinets or other configurations that can serve to protect the components and thus limit the ability of fire stream penetration. Firefighters should never use piercing nozzles and long penetrating irons. It is recommended that firefighters use the reach of the water stream instead but should never be up close to these installations. Mechanically damaged cells or puncturing unburned or undamaged cells can result in the immediate ignition of those cells. In addition, internal shorting within the cabinets could create an electrocution risk. The use of salt water on a damaged system will cause more electrical leakage back to the water appliance. Only unadulterated fresh water should be used on ECE hazardous materials. Movement of damaged cells might result in arcing or reignition if active material or cells remain in the modules. Modules should not be moved without consultation from a qualified ~~personnel~~ person. Firefighter should never attempt to “overhaul” a damaged ECE hazardous material. Ventilation during suppression is critical. Research has shown that Li-ion batteries might continue to generate flammable gases during and after extinguishing. In addition, testing has shown that during sprinkler suppression, removal of combustion and flammable gases emitted from the battery significantly improves the effectiveness of the suppression. Ventilation of an enclosure does not remove the potential of explosion. Ventilation manual activation devices that can be used in enclosure to exhaust flammable and toxic gases from within the enclosure must be remote from the installation and marked for fire department use. This option of ventilation of an enclosure should be in consultation with the system SME. No ventilation should be attempted by the fire service until more information is gathered and the area around the installation is secured. Testing has shown that electrical current leakage back through hose streams using unadulterated fresh water will not be a shock hazard when appropriate streams are used and distances maintained. Firefighters that use tower ladders (i.e., buckets) should be aware of explosion hazards and should not be in the explosion area when operating a water source from these types of apparatus. In cases where systems are destroyed and electric potential is shown to be minimal, close-range engagement with hoses for drowning modules can be performed to provide more direct cooling. During postfire operations, SCBA should continue to be worn by all persons near the damaged ESS, especially where systems are in confined or poorly ventilated spaces or have not been sufficiently cooled yet. There is a concern that the buildup of these gases can cause an explosion even after the fire has been put under control. Gases, and CO in particular, should be monitored during this period, as dangerous buildups have been observed during postfire testing. If possible, batteries should be monitored for residual heat and temperature, as reignition is a possibility in cells that are not sufficiently cooled. Care should be taken to secure the area where the batteries are located and ensure that the heat has been removed and that the batteries are not at risk of being electrically shorted or		

	mechanically damaged. This should be done at the guidance of a qualified ~~technician~~ person. At this point, the fire scene should be handed over to the owner, operator, or responsible party appointed by the site owner. Though trace amounts of heavy metals such as nickel and cobalt can be deposited from combustion of the batteries, these elements are not expected to be present in large quantities or in quantities larger than any other similar fire. In most instances, water exposed to the batteries shows very mild acidity, with an approximate pH of 6. Runoff-water pH can be monitored during firefighting operations but should not pose a greater risk than normal firefighting runoff. In unique cases where a system on fire poses little or no risk to the surrounding uninvolved equipment or the environment, it is reasonable to assume a defensive posture and allow the system to burn itself out. Some typical steps for this approach include local municipal firefighters responding to the scene to make sure that the flames do not spread beyond the property perimeter, having ESS operations personnel arriving at the scene to review the situation and conditions, and then allowing the fire to burn out. This option should only be considered when no risks are posed to the environment and the risk to firefighting operations is great or unknown. It is up to the site owner/operator to communicate with fire services in the event of an emergency to relay vital system information to fire services.
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Statement (technical reason for FR)	"Qualified" is used in different configurations thru out the standard. This updates the usage to be consistently applied throughout the standard.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
G.11.8.5	52	None	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	G.11.8.5 Types of Hazards Once a Fire has Started. Fire, explosions, toxic ~~gases~~ and highly toxic emissions, chemical hazards, CO, CO_2, hydrocarbons (i.e., typically propane and methane, but this depends on the chemistry of the specific battery), and H_2.
First Revision Text (FR)	G.11.8.5 Types of Hazards Once a Fire has Started. Fire, explosions, toxic and highly toxic emissions~~gases~~, chemical hazards, CO, CO2, hydrocarbons (i.e., typically propane and methane, but this depends on the chemistry of the specific battery), and H2.
Statement (technical reason for FR)	The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. The annex is updated to reflect these requirements.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	66#	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	Fire Risk Assessment (FRA). A process to characterize the risk associated with fire that addresses the fire scenario or fire scenarios of concern, their probability, and their potential consequences. Other documents may use other terms, such as fire risk analysis, fire hazard, hazard analysis, and fire hazard analysis assessment, to characterize fire risk assessment as used in this guide.		
First Revision Text (FR)	3.3.x Fire Risk Assessment (FRA). A process to characterize the risk associated with fire that addresses the fire scenario or fire scenarios of concern, their probability, and their potential consequences. Other documents may use other terms, such as fire risk analysis, fire hazard, hazard analysis, and fire hazard analysis assessment, to characterize fire risk assessment as used in this guide.		
Statement (technical reason for FR)	Fire risk assessment (FRA) is used 5 times in NFPA 855. It is not defined in the standard. It is part of the HMA process requirements. Utilizing the definition from NFPA 551 to incorporate into NFPA 855.		
Response (technical reason for not making some changes or for resolving)			

New Definition	65#	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	**Failure Modes and Effects Analysis (FMEA)** - **"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the End user, and can be potential or actual.** - **"Effects analysis" refers to studying the consequences of those failures.** **Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. It is used during design to help mitigate against failures. It is to take actions to eliminate or reduce failures, starting with the highest-priority ones. It begins during the earliest conceptual stages of design and continues throughout the life of the BESS products and services.**		
First Revision Text (FR)	3.3.x* Failure Modes and Effects Analysis (FMEA) - "Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the End user, and can be potential or actual. - "Effects analysis" refers to studying the consequences of those failures.		

	A.3.3.x Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. It is used during design to help mitigate against failures. It is to take actions to eliminate or reduce failures, starting with the highest-priority ones. It begins during the earliest conceptual stages of design and continues throughout the life of the BESS products and services.
Statement (technical reason for FR)	FMEA is used 6 times in the 855 Standard. It is not defined within the standard nor the NFPA codes. FMEA is part of the HMA process.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.2.1.3	67#	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.2.1.3 The following test data, evaluation information, and calculations shall be provided in addition to the plans and specifications in 4.2.1.1 where required elsewhere in this standard: (1) Fire and explosion testing data in accordance with 9.1.5 (2) Hazard mitigation analysis (HMA) in accordance with Section 4.4 (3) Calculations or modeling data to determine compliance with explosion control in accordance with 9.6.5.6.3 (4) Other test data, evaluation information, or calculations as required elsewhere in this standard		
First Revision Text (FR)	4.2.1.3 The following test data, evaluation information, and calculations shall be provided in addition to the plans and specifications in 4.2.1.1 where required elsewhere in this standard: 1. Fire and explosion testing data in accordance with 9.1.5 2. Hazard mitigation analysis (HMA) in accordance with Section 4.4 3. Calculations or modeling data to determine compliance with ~~NFPA 68 and NFPA 69~~ explosion control in accordance with 9.6.5.6.3 4. Other test data, evaluation information, or calculations as required elsewhere in this standard		

Statement (technical reason for FR)	Simplified to not be specific to NFPA 68 and 69 as NFPA 68 may not be a viable options and other options such as testing may be applicable.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.4.2.1	68#	~~110~~	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	4.4.2.1* The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ: (1) A thermal runaway or mechanical failure condition in a single ESS unit (2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA) ~~Failure of a required protection system including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection~~ (3) As identified in a site level Fire Risk Assessment (FRA) or a Site level FMEA.
First Revision Text (FR)	4.4.2.1* The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ: 1. A thermal runaway or mechanical failure condition in a single ESS unit 2. Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA) 3. Failure of a required ~~protection~~ system including, but not limited to, ventilation (HVAC), cooling system, BMS, communication system, or other critical systems that may impact normal operations. A.4.4.2.1 Failures modes covered by 4.4.2 can include mechanical failure modes and are applicable to flywheel, stored pressure, and other types of ESS other than electrochemical ESS.

<table>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">There is interpretation in the industry that a signal failure mode would be defined as either a battery failure or a protection system and not both. As a critical safety system must function in single failure mode, it needs to be separate, defined and evaluated independent of a FMEA and equipment failure. Required system and critical system have been separated to be evaluated separately.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>4.4.2.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>110#</td><td>~~68~~</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.4.2.1*
The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:
(1) A thermal runaway or mechanical failure condition in a single ESS unit
(2) Failure of ~~an energy storage management system or~~ a protection system that is~~ not covered by the product listing failure modes and effects analysis (FMEA)~~ provided outside of the listed ESS
(3) Failure of a required protection system including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3"></td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3">There are partial systems that are part of the 9540 listing that haven't been evaluated as part of the complete systems. It would lock the AHJ into accepting these systems.</td></tr>
</table>

<table>
<tr><td>Section</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>New 4.4.2.3</td><td>69#</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.4.2.3*
Failure of a required or integral protection system including, but not limited to, ~~ventilation~~HVAC or cooling system~~ (HVAC)~~, exhaust ventilation, smoke detection, fire detection, fire suppression, ~~or~~ gas detection, TRM or explosion control system shall be evaluated to confirm the safety systems will operate and support mitigation measures in a ~~-~~failure event.</td></tr>
</table>

	A.4.4.2.3 Failure of an integral safety system such as the fire alarm and explosion control system is not considered a dual fault condition. An example may be the loss of primary power or secondary power. This would be considered above and beyond the normal safety listing and evaluation. The protection features are required because the standard assumes an uncontrol event occurred.
First Revision Text (FR)	4.4.2.3* Consequences of single failures of critical safety component or system such as, exhaust ventilation, smoke detection, fire detection, fire suppression, gas detection or explosion control systems during a thermal runaway or failure event shall be evaluated. A.4.4.2.3 Failure of a critical safety component or system such as the fire alarm and explosion control system are not considered a dual fault condition. An example may be the loss of primary power or secondary power. This would be considered above and beyond the normal safety listing and evaluation. The protection features are required because the standard assumes an uncontrol event occurred.
Statement (technical reason for FR)	There is an interpretation in the industry that a signal failure mode or failure event would be defined as either a battery failure or a protection system and not both. A critical safety system must function in failure event, to be separate, defined and evaluated independent of a FMEA and equipment failure. These systems need to function and provide protection during an event, similar to the requirements of reliable power and backup power under the requirement of NFPA 72.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.1.5.1	263, 355, Annex 37, 356#		☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.1.5.1 Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS ~~in accordance with UL 9540A or equivalent test standard~~.		
First Revision Text (FR)	See below revised text		

Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)			
9.1.5.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	355#	263	☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.1.5.1 Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A ~~or equivalent test standard~~.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)			
A.9.1.5.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	356#	37	☐ Create First Revision ☐ Resolve
Proposed Text (PI)	A.9.1.5.1 ~~UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of gases generated at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.~~ The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway~~.~~		

	The test sequence in UL 9540A includes, in order, cell, module, unit and installation level tests. If the following individual test results are obtained no further testing in the sequence is needed. **Cell level test**– Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918. **Module level test**– The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable **Unit level test**- All of the following results are obtained: 1. Target BESS temperatures less than cell surface temperature at gas venting, and meets the heat flux limits for means of egress. 2. Temperature increase of target walls less than 97 °C (175 °F) 3. No explosion hazards exhibited by the product 4. No flaming beyond outer dimensions of BESS unit (indoor, wall mount) **Installation level test**– Acceptable performance includes all of the following: 1. Target BESS temperatures less than cell surface temperature at gas venting, and meets the heat flux limits for means of egress. 2. Temperature increase of target walls less than 97 °C (175 °F) 3. The flame indicator does not propagate flames beyond the width of the initiating BESS 4. No flaming outside the test room, and meets the heat flux limits for the means of egress. The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire and explosion protection required for an ESS installation.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

A.9.1.5.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

<table>
<tr><td></td><td>263, 355, 37,356#</td><td>356</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.9.1.5.1
A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of both explosive gases generated and toxic and highly toxic emissions at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire and explosion protection required for an ESS installation.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Since the code assumes compete failure of a unit or cabinets, this will require an ignition source to ignite those technologies that produce combustible gases during 9540A but do not catch fire. Currently an outdoor ESS unit can "pass" UL9540A if no visible flames are observed, however copious quantities of smoke/vent/off-gas may be emanating from the ESS. Based on cell and module level testing we know that this mixture is flammable and often may ignite in which case the fire may be sustained and propagate internally or to adjacent/target units. As these are one-off tests there is an aspect of uncertainty and thus ensuring that the gases released are ignited, if possible, will ensure that the fire propagation hazard is sufficiently evaluated.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.1.5.1*
Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standard.
A.9.1.5.1
A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of gases generated at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to</td></tr>
</table>

determine the need for fire and explosion protection required for an ESS installation

~~9.1.5.1*~~

~~Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, propagation potential at a module level and propagation potential between containers.~~

~~A.9.1.5.1~~

~~A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of both explosive gases generated and toxic and highly toxic emissions at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard.~~

~~The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.~~

The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway~~.~~

The test sequence in UL 9540A includes, in order, cell, module, unit and installation level tests. If the following individual test results are obtained no further testing in the sequence is needed.

Cell level test– Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918.

Module level test– The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable.

Unit level test - All of the following results are obtained:

1. Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress
2. Temperature increase of target walls less than 97 °C (175 °F)

	3. No explosion hazards exhibited by the product 4. No flaming beyond outer dimensions of BESS unit (indoor, wall mount) **Installation level test**– Acceptable performance includes all of the following: 1. Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress. 2. Temperature increase of target walls less than 97 °C (175 °F) 3. The flame indicator does not propagate flames beyond the width of the initiating BESS 4. No flaming outside the test room and meets the heat flux limits for the means of egress. The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire and explosion protection required for an ESS installation ~~The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire, explosion and toxic and highly toxic emission protection required for an ESS installation.~~

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.1.5.1.2.1	313, 70 (same revision)#	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.1.5.1.2.1* When cell thermal runaway results in the release of flammable gases during a cell or module level test, a unit level test shall be conducted involving intentional ignition of the vent gases to assess the fire propagation hazard. A. 9.1.5.1.2.1 Intentional ignition of the vent gases informs the degree of fire hazard presented by the released flammable gases and the development of a fire protection strategy. The ignition source should be of sufficient magnitude such as generated by a spark igniter, glow plug, or pilot flame located in close proximity to the origin of the vented gases, but outside of the module of origin, to cause prompt ignition of the flammable gases. External ignition in this manner is not intended to address deflagration mitigation as required in 9.1.5.1.4.		

First Revision Text (FR)	9.1.5.1.2* ~~The testing shall be conducted or witnessed and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.~~ When cell thermal runaway results in the release of flammable gases during a cell or module level test, a unit level test shall be conducted involving intentional ignition of the vent gases to assess the fire propagation hazard. A. 9.1.5.1.2.1 Intentional ignition of the vent gases informs the degree of fire hazard presented by the released flammable gases and the development of a fire protection strategy. The ignition source should be of sufficient magnitude such as generated by a spark igniter, glow plug, or pilot flame located in close proximity to the origin of the vented gases, but outside of the module of origin, to cause prompt ignition of the flammable gases. External ignition in this manner is not intended to address deflagration mitigation as required in 9.1.5.1.4. 9.1.5.1.2.1* The large-scale fire testing ~~per~~in accordance with -9.1.5.1.2 shall be conducted or witnessed and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit. **9.1.5.1.2.2** Proposed spacing between cabinets for outdoor ESS installations consisting of multiple cabinets shall be validated using large-scale fire testing ~~per~~ in accordance with Section 9.1. and reviewed by a registered design professional to verify that complete combustion of one cabinet shall not result in propagation to adjacent cabinets-.
Statement (technical reason for FR)	Since the code assumes compete failure of a unit or cabinets, this will require an ignition source to ignite those technologies that produce combustible gases during 9540A but do not catch fire. Currently an outdoor ESS unit can "pass" UL9540A if no visible flames are observed, however copious quantities of smoke/vent/off-gas may be emanating from the ESS. Based on cell and module level testing we know that this mixture is flammable and often may ignite in which case the fire may be sustained and propagate internally or to adjacent/target units. As these are one-off tests there is an aspect of uncertainty and thus ensuring that the gases released are ignited, if possible, will ensure that the fire propagation hazard is sufficiently evaluated.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New A.9.1.5.1.4	316, 315 (annex)#	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.1.5.1.4* The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets. A.9.1.5.1.4 Currently the de-facto large-scale test, UL9540A, lumps the fire hazard and explosion together and assumes that if no deflagration is observed then the ESS system is safe. The provision of an evaluation of deflagration hazard mitigation is important and independent from the fire hazard evaluation and is necessary to ensure that the NFPA 68, NFPA 69, or alternative deflagration protection measure is appropriate for the ESS design.		
First Revision Text (FR)	9.1.5.1.4* The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets. A.9.1.5.1.4 Currently the de-facto large-scale test, UL9540A, lumps the fire hazard and explosion together and assumes that if no deflagration is observed then the ESS system is safe. The provision of an evaluation of deflagration hazard mitigation is important and independent from the fire hazard evaluation and is necessary to ensure that the NFPA 68, NFPA 69, or alternative deflagration protection measure is appropriate for the ESS design. 9.1.5.1.4.1 When cell thermal runaway results in the release of flammable gases during a cell or module level test, a unit level test shall be conducted involving intentional ignition of the vent gases to assess the explosion hazard.		
Statement (technical reason for FR)	This will require an ignition source to ignite those technologies that produce combustible gases during 9540A but do not explode. Currently an outdoor ESS unit can "pass" UL9540A if no visible flames are observed, however copious quantities of smoke/vent/off-gas may be emanating from the ESS. Based on cell and module level testing we know that this mixture is flammable and often may ignite and cause deflagration As these are one-off tests there is an aspect of uncertainty and thus ensuring that the gases released are ignited, if possible, will ensure that the deflagration hazard is sufficiently evaluated.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

A.9.1.5.2	358#	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	A.9.1.5.2 The test report will provide nonproprietary information that, among other things, describes the size and energy capacity rating of the unit being tested, model numbers of the modules and ESS units, orientation of ESS in the test facility, and proximity of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of test results and measurements. ~~For example, a complete UL 9540A test report that includes a unit level test should also include the UL 9540A cell and module level test.~~		
First Revision Text (FR)	A.9.1.5.2 The test report will provide nonproprietary information that, among other things, describes the size and energy capacity rating of the unit being tested, model numbers of the modules and ESS units, orientation of ESS in the test facility, and proximity of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of test results and measurements. For example, a complete UL 9540A test report that includes a unit level test should also include the UL 9540A cell and module level test.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This data is critical to engineering evaluation for fire and explosion.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New A.9.1.5.2.1	366#	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	9.1.5.2.1* The complete test report and its supporting data shall be provided to the AHJ for review and approval. A.9.1.5.2.1 The complete test report should include all required UL 9540A test results. Depending on results obtained, as described in A.9.1.5.1, the report may not include all potential tests in the sequence.		
First Revision Text (FR)	9.1.5.2.1 The complete test report and its supporting data shall be provided to the AHJ for review and approval.		

Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Each test level is required for engineered evaluation.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.1.5.2.2.1	368#	None	☐ Create First Revision X☐ Resolve

Proposed Text (PI)	9.1.5.2.2.1* For ESS installations in one- and two-family dwellings and townhouse units regulated by Chapter 15, the supplemental report in 9.1.5.2.2 shall be provided by an approved qualified person or a registered design professional. A.9.1.5.2.2.1 The requirements in 9.1.5.2.2 require supplemental reports to be provided for each ESS installation, and the individual reports would be stamped by a registered design professional. However given that many ESS installations in one- and two-family dwellings and townhouse housing developments use smaller, more standardized equipment and designs, there is no need for each supplemental report to be stamped by a registered design professional. For these installations a supplementary report, provided by an approved qualified person should suffice, and a single report may cover numerous installations in a typical housing development or installation scenario. The AHJ can still determine which persons can provide this report, and whether the report is applicable for a given installation.
First Revision Text (FR)	To create a FR, revise text above or paste final version here.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	This is conflict with recent TIA to remove the connection between Chapter 15 and Chapter 9 to separate the requirements for testing and registered design professional. PI 29 and 30

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.1.5.2.3	1	None	☐ Create First Revision ☒~~☐~~ Resolve

Proposed Text (PI)	9.1.5.2.3* For Chapter 15 ESS installations that do not exceed the individual or aggregate ratings referenced in 15.5.3, the AHJ shall be permitted to require the test report to be accompanied by a supplemental report prepared by an approved independent third party with expertise in the matter that provides an interpretation of the test data in relation to the installation requirements for the ESS. A.9.1.5.2.3 Section 1.3.2 indicates that ESS in one- and two-family dwellings and townhouses shall only be required to comply with Chapter 15. However, 15.3.1 identifies reduced spacing conditions which require fire and explosion testing to comply with 9.1.5. Since these residential ESS cannot exceed 20 kWh and the total aggregate energy of the installations is limited. This section does not apply to residential ESS that exceed the individual and aggregate ratings specified in 15.5.1 and 15.5.2, since 15.5.3 requires these larger systems to comply with commercial ESS requirements in Chapter 4 through 9.
First Revision Text (FR)	To create a FR, revise text above or paste final version here.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	This conflicts with recent TIA to remove the connection between Chapter 15 and Chapter 9 to separate the requirements for testing and registered design professional. PI 29 and 30

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 15.13	30	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.13 Fire and Explosion Testing. 15.13.1* Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standards. A.15.13.1 A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of gases generated at the cell, module, and unit and installation levels for ESS undergoing thermal runaways, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The fire and explosion testing data is intended to be used by manufacturers, system designers, and AHJs to determine if the required separation distance for an ESS installation can be reduced. 15.13.1.1		

	The complete UL 9540A or equivalent test report shall be provided to the Authority Having Jurisdiction, including the cell, module, and unit level. 15.13.1.2 Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when installed with a charging system listed to UL 1012, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778. 15.13.1.3 The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit. 15.13.1.4* The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation. A.15.13.1.4 changes in an installation configuration, including the internal architecture of modules and units that don't match the parameters tested, such as size and separation, cell type, or energy density, should only be accepted if it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might have yet to be evaluated in the test. 15.13.1.5 The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.
First Revision Text (FR)	Tie to PI 29 look and add justification.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	65	None	☒☐ Create First Revision ☐ Resolve

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">Failure Modes and Effects Analysis (FMEA)
• "Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the End user, and can be potential or actual.
• "Effects analysis" refers to studying the consequences of those failures.
Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. It is used during design to help mitigate against failures. It is to take actions to eliminate or reduce failures, starting with the highest-priority ones. It begins during the earliest conceptual stages of design and continues throughout the life of the BESS products and services.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">3.3.x Failure Modes and Effects Analysis (FMEA)
• "Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the End user, and can be potential or actual.
• "Effects analysis" refers to studying the consequences of those failures.
•
A.3.3.x
Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. It is used during design to help mitigate against failures. It is to take actions to eliminate or reduce failures, starting with the highest-priority ones. It begins during the earliest conceptual stages of design and continues throughout the life of the BESS products and services.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Currently FMEA is used 6 times in NFPA 855. It is not defined with in the standard nor NFPA codes. FMEA is part of the HMA process. Section 4.4.2.1.3(look at)</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New Section – CI</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td></td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">Water Run off and water impacts</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">Committee input to review water runoff –The TG doesn’t have enough data to evaluate thru PI. Address under Second revision PC in coordination with requirements of 9540A.
4.3.8 Technical Committee Input. When a technical committee is considering a revision to its NFPA Standard but does not wish to include the revision in the first draft, the technical committee may submit the revision for public review and consideration as a Committee Input for the sole purpose of seeking public consideration and soliciting</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">Public Comments. The decision to develop Committee Input shall be supported through a meeting vote requiring a simple majority and shall not be subject to ballot.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2"></td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>CI</td><td></td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">**3.3.14 Hazard Mitigation Analysis (HMA).**
An evaluation of potential energy storage system failure modes and the safety-related consequences attributed to the failures.
The process of identifying situations or conditions that have the potential to cause injury to people, damage to property, or damage to the environment. (additional language?)</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">CI to update definition to include FRA, site and product and possibly FMEA.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
</table>

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.3.1	55	83	☐ Create First Revision ☐ Resolve

Proposed Text (PI)

9.5.3.1

Rooftop and open parking garage ESS installations shall comply with this section and as detailed in Table 9.5.3.1.

Table 9.5.3.1 Rooftop and Open Parking Garage ESS Installations

Compliance Required	**Rooftops**	**Open Parking Garages**	**Reference**
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Means of egress separation	Yes	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Enclosures	Yes	Yes	4.6.12
Clearance to exposures	Yes	Yes	9.5.3.1.3
Fire suppression and control	Yes	Yes	9.5.3.1.4
Size and separation	Yes	Yes	9.4.2
Maximum stored energy	Yes	Yes	9.4.1
Elevation	Yes	Yes	4.7.7
Smoke and fire detection	Yes	Yes	9.6.1
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Open rack installations	Not allowed	Not allowed	4.7.9
Toxic and Highly Toxic Emissions	Yes	Yes	9.6.7
Technology-specific protection	Yes	Yes	9.6.5

NA: Not applicable.

First Revision Text (FR)

See below for revised text.

Statement (technical reason for FR)	From TG 6 addition of Toxics requirements to the table		
Response (technical reason for not making some changes or for resolving)			
9.5.3.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	83, 55		☒ Create First Revision ☐ Resolve
Proposed Text (PI)	Table 9.5.3.1 Rooftop and Open Parking Garage ESS Installations		

Table 9.5.3.1 Rooftop and Open Parking Garage ESS Installations

Compliance Required	**Rooftops**	**Open Parking Garages**	**Reference**
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Means of egress separation	Yes	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Enclosures	Yes	Yes	4.6.12
Clearance to exposures	Yes	Yes	9.5.3.1.3
Fire suppression and control	Yes	Yes	9.5.3.1.4
Size and separation	Yes	Yes	9.4.2
Maximum stored energy	Yes	Yes	9.4.1
Elevation	Yes	Yes	4.7.7
Smoke and fire detection	Yes	Yes	9.6.1
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Open rack installations	Not allowed	Not allowed	4.7.9
~~Technology-specific protection~~ Exhaust Ventilation during normal operations*	Yes	Yes	9.6.5.1

Spill Control*	Yes	Yes	9.6.5.2
Neutralization*	Yes	Yes	9.6.5.3
Safety Caps*	Yes	Yes	9.6.5.4
Thermal Runaway*	Yes	Yes	9.6.5.5
Explosion Control*	Yes	Yes	9.6.5.6

NA: Not applicable.

*Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in 3.3.9 shall comply or is exempt from this requirement.

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	As the technology specific protection table changes with the changes in technology and battery type, the applicable code requirements for location specific application is not always clear. Specific mitigation measures are added to the tables for guidance per locations. The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	

Table 9.5.3.1 Rooftop and Open Parking Garage ESS Installations

Compliance Required	Rooftops	Open Parking Garages	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Means of egress separation	Yes	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Enclosures	Yes	Yes	4.6.12
Clearance to exposures	Yes	Yes	9.5.3.1.3

Fire suppression and control	Yes	Yes	9.5.3.1.4
Size and separation	Yes	Yes	9.4.2
Maximum stored energy	Yes	Yes	9.4.1
Elevation	Yes	Yes	4.7.7
Smoke and fire detection	Yes	Yes	9.6.1
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Open rack installations	Not allowed	Not allowed	4.7.9
Toxic and highly toxic emissions	Yes	Yes	9.6.7
~~Technology-specific protection~~ Exhaust Ventilation during normal operations*	Yes	Yes	9.6.5.1
Spill sontrol*	Yes	Yes	9.6.5.2
Neutralization*	Yes	Yes	9.6.5.3
Safety caps*	Yes	Yes	9.6.5.4
Thermal runaway*	Yes	Yes	9.6.5.5
Explosion control*	Yes	Yes	9.6.5.6

NA: Not applicable.

*Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in 3.3.9 shall comply or is exempt from this requirement.

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>9.5.3.2.6</td><td>84</td><td>None</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">Table 9.5.3.2.6 Mobile Energy Storage Systems (ESS)
<table>
<tr><th>Compliance Required</th><th>Deployment</th><th>Reference</th></tr>
<tr><td>Administrative</td><td>Yes</td><td>Chapters 1–3</td></tr>
<tr><td>General</td><td>Yes</td><td>Sections 4.1–4.7</td></tr>
<tr><td>Size and separation</td><td>Yes[a]</td><td>9.4.2</td></tr>
</table></td></tr>
</table>

Maximum stored energy	Yes	9.4.1
Fire and smoke detection	Yes[b]	9.6.1
Fire control and suppression	Yes[c]	9.6.2
Maximum size	Yes	9.5.2.4
Vegetation control	Yes	9.5.2.2
Means of egress separation	Yes	9.5.2.6.1.7
~~Technology-specific protection~~ Exhaust Ventilation during normal operations*	Yes	9.6.5.1
Spill control*	Yes	9.6.5.2
Neutralization*	Yes	9.6.5.3
Safety Caps*	Yes	9.6.5.4
Thermal Runaway*	Yes	9.6.5.5
Explosion Control*	Yes	9.6.5.6

[a] In walk-in units, spacing is not required between ESS units and the walls of the enclosure.

[b] Alarm signals are not required to be transmitted to an approved location for mobile ESS deployed 30 days or less.

[c] Only required for walk-in units.

* Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in 3.3.9 shall comply or is exempt from this requirement.

First Revision Text (FR)

Table 9.5.3.2.6 Mobile Energy Storage Systems (ESS)

Compliance Required	**Deployment**	**Reference**
Administrative	Yes	Chapters 1–3
General	Yes	Sections 4.1–4.7
Size and separation	Yes[a]	9.4.2
Maximum stored energy	Yes	9.4.1
Fire and smoke detection	Yes[b]	9.6.1
Fire control and suppression	Yes[c]	9.6.2
Maximum size	Yes	9.5.2.4
Vegetation control	Yes	9.5.2.2
Means of egress separation	Yes	9.5.2.6.1.7
Toxic and Highly Toxic Emissions	Yes	9.6.7
~~Technology-specific protection~~ Exhaust Ventilation during normal operations*	Yes	9.6.5.1
Spill control*	Yes	9.6.5.2
Neutralization*	Yes	9.6.5.3
Safety caps*	Yes	9.6.5.4
Thermal runaway*	Yes	9.6.5.5
Explosion control*	Yes	9.6.5.6

[a] In walk-in units, spacing is not required between ESS units and the walls of the enclosure.

[b] Alarm signals are not required to be transmitted to an approved location for mobile ESS deployed 30 days or less.

[c] Only required for walk-in units.

* Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in 3.3.9 shall comply or is exempt from this requirement.

Statement (technical reason for FR)	As the technology specific protection table changes with the changes in technology and battery type, the applicable code requirements for location specific application is not always clear. Specific mitigation measures are added to the tables for guidance per locations. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Response (technical reason for not making some	

changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.1.2	336		☐ Create First Revision ☒ Resolve
Proposed Text (PI)	~~9.6.5.1.2 Abnormal Conditions.~~ ~~Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6.~~		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This section is used to point to the section for abnormal conditions to make sure that exhaust ventilation is not used for abnormal conditions. Due to confusion in the industry this section needs to stay for clarity.		
9.6.5.1.2.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	39		☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.1.2 Abnormal Conditions. 9.6.5.1.2.1 Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6. 9.6.5.1.2.2 Protection against toxic or Highly toxic emissions during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.7.		
First Revision Text (FR)	9.6.5.1.2 Abnormal Conditions. 9.6.5.1.2.1 Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6. 9.6.5.1.2.2 Protection against toxic or highly toxic emissions during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.7.		

Statement (technical reason for FR)	Anew section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. This addition helps direct the user to the new toxic chapter.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.1.3	328	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.1.3 Indoor ESS Cabinets. Exhaust ventilation for ESS cabinets installed indoors shall ~~evaluate air movement through~~ be provided for both the cabinet and ~~exhaust from~~ for the room.		
First Revision Text (FR)	9.6.5.1.3 Indoor ESS Cabinets. Exhaust ventilation for ESS cabinets installed indoors shall include an evaluation of the air movement for both the cabinet and for the room for the basis of the design. . Exhaust ventilation for ESS cabinets installed indoors shall include an evaluation of the air movement for both the cabinet and for the room for the basis of the design.		
Statement (technical reason for FR)	This wording is an improvement over the current sentence which essentially states "exhaust ventilation shall evaluate".		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.1.4	94	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.1.4* Natural Exhaust Ventilation. Exhaust ventilation shall be designed to limit the maximum concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume of the outdoor cabinet during the worst-case ~~event of~~ conditions, including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards.		

First Revision Text (FR)	9.6.5.1.4*- Outdoor Cabinets. . Natural exhaust ventilation for outdoor cabinets shall be designed to limit the maximum concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume during the worst-case conditions, including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards.
Statement (technical reason for FR)	Flow batteries, and potentially other technologies may produce hydrogen during conditions other than charging. This revision makes these requirements broader in scope. This requirement is specific to outdoor cabinets and has been noted as such.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION	
9.6.5.1.5	95	None	☒ Create First Revision ☐ Resolve	
Proposed Text (PI)	9.6.5.1.5 Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following: (1) Where hydrogen is the gas generated, an exhaust ventilation rate based on hydrogen generation estimates sufficient to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room, walk-in unit, or cabinet during the worst-case ~~event of~~ conditions, including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards (2) An exhaust ventilation rate based on the area of not less than 1 $ft^3/min/ft^2$ (5.1 $L/sec/m^2$) of floor area of the room, walk-in unit, enclosure, container, or cabinet			
First Revision Text (FR)	9.6.5.1.5 Mechanical Exhaust Ventilation. Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following: 1. Where hydrogen is the gas generated, an exhaust ventilation rate based on hydrogen generation estimates sufficient to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room, walk-in unit, or cabinet during the worst-case conditions, including, simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards 2. An exhaust ventilation rate based on the area of not less than 1 $ft^3/min/ft^2$ ($5.1 L/sec/m^2$) of floor area of the room, walk-in unit, enclosure, container, or cabinet			

<table>
<tr><td>Statement
(technical reason for FR)</td><td>Flow batteries, and potentially other technologies may produce hydrogen during conditions other than charging. This change is intended to make these requirements broader in scope.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td></td></tr>
</table>

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>9.6.5.1.5.1</td><td>332</td><td>None</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.1.5.~~1~~ 3

Mechanical exhaust ventilation shall be either continuous or activated by a gas detection system in accordance with 9.6.5.1.5.4.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.6.5.1.5.~~1~~3

Mechanical exhaust ventilation shall be either continuous or activated by a gas detection system in accordance with 9.6.5.1.5.4.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">No technical change, move this requirement directly before 9.6.5.1.4 as 9.6.5.1.4 addresses how to accommodate one of the options, while 9.6.5.1.2 and 9.6.5.1.3 are more generally applicable to mechanical exhaust. NFPA to renumber accordingly.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
</table>

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>9.6.5.1.5.4</td><td>333</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.1.5.4*

Where gas detection is used to activate exhaust ventilation in accordance with 9.6.5.1.5.1, rooms, walk-in units, enclosures, walk-in containers, and cabinets containing ESS shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the mechanical exhaust ventilation system ~~when~~ whenever the level of flammable gas detected in the room, walk-in unit, enclosure, container, and cabinet exceeds 25 percent of the LFL of the flammable gas mixture.</td></tr>
</table>

	(3) ~~The mechanical exhaust ventilation system shall remain on until the flammable gas detected is less than 25 percent of the LFL of the flammable gas mixture.~~ (3) The gas-detection system shall be provided with a minimum of 2 hours of standby power. (4) Failure of the gas detection system shall annunciate a trouble signal at an approved central, proprietary, or remote station in accordance with *NFPA 72* or at an approved, constantly attended location.
First Revision Text (FR)	**9.6.5.1.5.4*** Where gas detection is used to activate exhaust ventilation in accordance with 9.6.5.1.5.1, rooms, walk-in units, enclosures, walk-in containers, and cabinets containing ESS shall be protected by an approved continuous gas detection system that complies with the following: 1. The gas detection system shall be designed to activate the mechanical exhaust ventilation system whenever the level of flammable gas detected in the room, walk-in unit, enclosure, container, and cabinet exceeds 25 percent of the LFL of the flammable gas mixture. ~~2. The mechanical exhaust ventilation system shall remain on until the flammable gas detected is less than 25 percent of the LFL of the flammable gas mixture.~~ ~~3.~~2. The gas detection system shall be provided with a EPSS and SEPSS ~~per chapter~~in accordance with Section 4.10. ~~minimum of 2 hours of standby power.~~ ~~4.~~3. Failure of the gas detection system shall annunciate a trouble signal at an approved central, proprietary, or remote station in accordance with *NFPA 72* or at an approved, constantly attended location.
Statement (technical reason for FR)	The exhaust runs whenever the 25% of LFL is exceeded. Also including the backup requirements per the new power section of 4.10 on Emergency power standby systems.
Response (technical reason for not making some changes or for resolving)	

<table>
<tr><td rowspan="2">9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>104</td><td>253, 129, 79</td><td>☒☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.
(4) For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.
(5) The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location:
(a) A trouble signal upon failure of the gas detection system
(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>129</td><td>253, 104, 79</td><td>☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.
(4) For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA.
(5) The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with *NFPA 72*, or at an approved constantly attended location:
(a) A trouble signal upon failure of the gas detection system
(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>9.6.5.6.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>79<u>, 253,104,129</u></td><td>~~253, 104, 129~~</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7
Where gas detection is used to activate a combustible gas concentration reduction system and based on an appropriate NFPA 69 deflagration study, enclosures containing ESS shall be protected by an approved continuous gas detection system that complies with the following:
(1) The gas detection system shall be designed to activate the combustible gas concentration reduction system on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
(2) The combustible gas concentration reduction system shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.</td></tr>
</table>

	(3) The gas detection ~~system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power~~ shall be installed in accordance with NFPA 72. (4) For lithium-ion batteries, the gas detection system and combustible gas concentration reduction systems shall be provided with a minimum of 24 hours of standby power while in a non-alarm condition and 2 hours of power in alarm condition or as required by the HMA. (5) The gas detection system and combustible gas concentration reduction system status shall annunciate the following at an approved central, proprietary, or remote station as required by the AHJ to provide situational information to the first responder in accordance with *NFPA 72*, or at an approved constantly attended location: (a) A trouble signal upon failure of the gas detection system or the combustible Gas concentration reduction system. (b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	additional clarity added for standby power tied to new chapter 4.10, and locations that a failed condition must be annunciated for First responder protection. Define that interaction between suppression system and combustible gas detection needs to be evaluated. An inspection and testing of the CGCRS needs to be maintained with in NFPA 69. The changes for Section 9.6.5.6 add addition clarification on the backup power requirements; use of gas detection and detection levels; options for other detections for explosion control; Remove multiple area designations as they just caused confusion especially as technologies change. Simplify requirement to all ESS. Additionally, remove the option for NFPA 68 compliance as for large scale gas deflagrations, they have not shown to be effective at mitigating the pressure release.
Response (technical reason for not making some changes or for resolving)	

FR text

9.6.5.6.7* **(PI -79, 253,104,129 - FR)**

Where gas detection is used to activate a combustible gas concentration reduction system (CGCRS) and based on an appropriate NFPA 69 deflagration study, BESS systems shall be protected by an approved continuous gas detection system that complies with the following:

1. The gas detection system shall be designed to activate the CGCRS on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.
2. The CGCRS shall remain on to ensure the flammable gas does not exceed 25 percent of the LFL of the gas mixture or of the individual components.
3. The gas detection system and CGCRS shall be provided with EPSS or SEBSS per ~~s~~Section 4.10.
4. For lithium-ion batteries, the gas detection system and CGCRS EPSS or SEBSS shall be provided with a minimum of 24 hours of standby power while in a non-alarm condition and 2 hours of power in an alarm condition .
5. The gas detection system and CGCRS status shall annunciate the following at a supervising station as required by the AHJ to provide situation information to first responders in accordance with *NFPA 72*, or at an approved constantly attended location:
    1. ~~(a)~~ A trouble signal upon failure of the gas detection system or the combustible gas concentration reduction system.
    2. ~~(b)~~ An alarm signal if flammable gas concentration exceeds 10 percent of the LFL

9.6.5.6.7.1 Other technologies, besides gas detection, used for detection, notification, and initiation of the CGCRS shall be evaluated by a registered design professional with experience in fire protection per the HMA.

9.6.5.6.7.2 The HMA shall include an analysis to ensure survivability of the CGCRS up until fire occurs.

9.6.5.6.7.3
Where suppression systems other than water based are contained within an ESS, the detection, logic solvers and sequence of events for discharge shall not impede the CGCRS performance. An analysis of no impact shall be provided to the AHJ along with performance data.

9.6.5.6.7.2 CGCRS shall meet the test and inspection requirements of NFPA 69 section 15.

<table>
<tr><td>Section</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>New 4.11</td><td>126, 335</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.11 Electric Vehicle Charging Stations
4.11.1
The requirements of this chapter shall apply to all Electric Vehicle Supply Equipment (EVSE) stationary charging equipment with an integrated ESS.
4.11.2* No annex material in PI the asterisk was left behind by mistake
ESS integrated with charging equipment shall comply with all applicable requirements in NFPA 855 and the following.
4.11.2.1
The EVSE shall be listed.
4.11.2.2
The installation shall be in accordance with NFPA 70 (NEC).
4.11.2.3
The electric vehicles being charged shall not be considered an exposure.
4.11.2.4
Individual EVSE with integral ESS with maximum stored energy less than 50 kWh shall not require fire barriers in 9.6.4.
4.11.2.5
EVSE electrical disconnects shall be remotely located at an approved location.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.11 Electric Vehicle Charging Systems
4.11.1 Electric vehicle charging systems that utilize ESS in excess of the limits in Table 1.3 shall comply with this section.
4.11.2 Equipment shall comply with all applicable requirements for the ESS technology it utilizes.
4.11.3* Equipment shall be listed and labeled.
A 4.11.3 UL is developing a standard to address EV charging system coupled with energy storage that requires the ESS to comply with applicable UL 9540 construction and performance requirements.
4.11.4 Vehicle impact protection for the ESS portion shall be provided in accordance with 4.7.5.2
4.11.5 Electrical disconnects shall comply with NFPA 70.</td></tr>
</table>

Statement (technical reason for FR)	This new section addresses electric vehicle charging technology that incorporates energy storage.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.5.2.6.1.9			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	9.5.2.6.1.9 The EV being charged shall not be considered an exposure for the EV charging equipment with integral ESS.		
Statement (technical reason for FR)	New 9.5.2.6.1.9 appropriately ties the new Section 4.11 to 9.5.2.6 for locations near exposures. This qualifies that the electric vehicle itself is not a fire exposure and therefore omitted from meeting any clearances and distances.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.5.4	139 (move to Chapter 15), 185 (delete redundant with 15.8)	See PI 140 on next table for similar revision	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	~~4.7.5.4*~~ ~~For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle.~~		

First Revision Text (FR)	4.7.5.4* For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle. A.4.7.5.4 ESS installed in residential garages should not be installed in a location where a motor vehicle being parked in the garage could come in contact with the ESS. Protection can be provided by approved barriers, by locating the ESS upon a 6 in. (152.4 mm) high platform located to the side of the garage, by locating the ESS components at a level above the potential impact height, or by recessing the ESS to one side of the space where the garage door is not the full width of the garage.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	The section as written is appropriate and does not warrant to be stricken out of Chapter 4 and moved solely into Chapter 15. A gap in the residential Chapter 15, Section 15.8 was identified. Section 15.8 is revised by separate revision to mirror what current 4.7.5.4 requires.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
15.4.1	157 ~~(See PIs 139 and 185 above for similar revision)~~		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.4.1 ESS shall only be installed in the following locations: (1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code (2) In detached garages and detached accessory structures (3) Outdoors on exterior walls or on the ground located a minimum of 3 ft (914 mm) from doors and windows directly entering the dwelling unit (4) In enclosed utility closets and storage or utility spaces where approved by the AHJ (5) For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle.		

First Revision Text (FR)	15.8 ~~Protection from Impact.~~ ~~ESS installed in a location subject to vehicle damage shall be protected by approved barriers.~~ For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle. A.15.8 ESS installed in residential garages should not be installed in a location where a motor vehicle being parked in the garage could come in contact with the ESS. Protection can be provided by approved barriers, by locating the ESS upon a 6 in. (152.4 mm) high platform located to the side of the garage, by locating the ESS components at a level above the potential impact height, or by recessing the ESS to one side of the space where the garage door is not the full width of the garage.
Statement (technical reason for FR)	A gap in the residential Chapter 15, Section 15.8 was identified. Section 15.8 is revised to mirror what the current 4.7.5.4 requires.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	31	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	Toxic Gas. A gas with a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [55,2020]		
First Revision Text (FR)	Toxic Gas. A gas with a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [55, 2023]		
Statement (technical reason for FR)	Toxic emissions are not adequately addressed in the current addition of NFPA 855. Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. Definitions of terms used in NFPA 855 have been added from NFPA 55.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	32	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	Highly Toxic Gas. A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [55,2020]		
First Revision Text (FR)	Highly Toxic Gas. A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [55, 2023]		

Statement (technical reason for FR)	Toxic emissions are not adequately addressed in the current addition of NFPA 855. Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. Definitions of terms used in NFPA 855 have been added from NFPA 55
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	33	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	Minimum Approach Distance (MAD) The distance from the perimeter of an Energy Storage System at which a Qualified Person or first responder can reasonably expect to avoid health impacts from heat, pressure, and toxic risks associated with a failure of the Energy Storage System, as determined by the Hazard Mitigation Analysis and/or fire and explosion testing, without the use of personnel protective equipment.		
First Revision Text (FR)	3.3.x* Minimum Approach Distance (MAD) The distance from the perimeter or failure point of an energy storage system at which a person can reasonably expect to avoid health impacts from heat, pressure, and toxic risks associated with a failure of the energy storage system, as determined by the hazard mitigation analysis and fire and explosion testing, without the use of personnel protective equipment. A.3.3.x The MAD is a theoretical evaluation and should not be confused with initial approach distance from the first responders that will be determined by actual situation conditions.		
Statement (technical reason for FR)	A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. This adds a definition of the term used in NFPA 855. MAD is also associated with pressure waves, deflagrations and heat defined distances		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	34	None	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)	Toxic Emissions Toxic species (gases, particulate, liquid or solid) released (into the environment where humans may be exposed. A.3.3.x While many ESS technologies use toxic materials and can produce toxic byproducts (particularly during an abnormal event, such as thermal runaway or fire), there is a difference between generation and emission. If the toxic species is generated internal to the battery (or by fire suppression system interaction with the ESS) but is consumed internally or is combusted or reacts to form other non-toxic compounds prior to human exposure it is not considered to be “emitted”.
First Revision Text (FR)	3.3.x* Toxic Emissions Toxic chemical species (gases, particulate, liquid or solid) that are released into the environment. A.3.3.x While many ESS technologies and systems use toxic materials and/or can produce toxic byproducts. They may be produced during an abnormal event, such as thermal runaway or fire and may be picked up during fire testing, but there is a difference between generation and emission. If the toxic species is generated internal to the battery but is consumed internally or is combusted or reacts to form other non-toxic compounds prior to human exposure it is not considered to be “emitted”.
Statement (technical reason for FR)	Toxic emissions are not adequately addressed in the current addition of 855. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. This adds a definition of the term used in NFPA 855.
Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>4.6.11</td><td>35</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.6.11*   ESS Toxic and Highly Toxic Gas ~~Release~~ Emitted During Normal Use.
ESS shall not ~~release~~ emit toxic or highly toxic gases during normal charging, discharging, and use.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">While many ESS technologies use toxic materials and can produce toxic byproducts (particularly during an abnormal event, such as thermal runaway or fire), there is a difference between generation or released and emission. If the toxic species is generated internal to the battery (or by fire suppression system interaction with the ESS) but is consumed internally or is combusted or reacts to form other non-toxic compounds prior to human exposure it is not considered to be “emitted”.</td></tr>
<tr><td>Response (technical reason for</td><td colspan="3"></td></tr>
</table>

not making some changes or for resolving)			
A.4.6.11	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	36	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.4.6.11 It is not the intent of 4.6.11 to address the presence of toxic and highly toxic ~~gases~~ emissions that are produced during abnormal conditions, such as a fire in the building or thermal runaway (see section 9.6.5.6). Certain metal oxides, heavy metals, and toxic liquids or particulates that are not gasses may be emitted from various battery types.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	Toxic emissions are not adequately addressed in the current addition of 855. Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			
First Revision Text (FR)	4.6.11* ESS Toxic and Highly Toxic Gas ~~Release~~ Emitted During Normal Use. ESS shall not ~~release~~ emit toxic or highly toxic gases during normal charging, discharging, and use. A.4.6.11 It is not the intent of 4.6.11 to address the presence of toxic and highly toxic ~~gases~~ emissions that are produced during abnormal conditions, such as a fire in the building or thermal runaway (see section 9.6.5.6). Certain metal oxides, heavy metals, and toxic liquids or particulates that are not gasses may be emitted from various battery types.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	81, 53		☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

9.5.1 Indoor Installations.

Indoor ESS installations shall comply with this section and as detailed in Table 9.5.1.

Table 9.5.1 Indoor ESS Installations

Compliance Required	**ESS Dedicated-Use Buildings**	**Non-Dedicated-Use Buildings**	**Reference**
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Size and separation	Yes	Yes	9.4.2
Maximum stored energy	No	Yes	9.4.1
Elevation	Yes	Yes	4.7.7
Fire barriers	NA	Yes	9.6.4
Smoke and fire detection	Yes	Yes	9.6.1
Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Yes	9.5.1.2.1
Toxic and highly toxic emissions	Yes	Yes	9.6.7
~~Technology-specific protection~~Exhaust ~~Ventilation~~ ventilation ~~During~~ during normal operation*	Yes	Yes	9.6.5.1
Spill control*	Yes	yes	9.6.5.2
Neutralization*	Yes	Yes	9.6.5.3
Safety caps*	Yes	Yes	9.6.5.4
Thermal runaway*	Yes	Yes	9.6.5.5
Explosion control*	Yes	Yes	9.6.5.6

NA: Not applicable.

*Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in section 3.3.9 shall comply or is exempt from this requirement.

First Revision Text (FR)

See above for revised text.

Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. As the technology specific protection table changes with the changes in technology and batter type, the applicable code requirements for location specific application is not always clear. The specific mitigation measures are added to the tables for guidance per locations.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	82, 54	~~54~~	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

9.5.2 Outdoor Installations.

Outdoor ESS installations shall comply with this section and as detailed in Table 9.5.2.

Table 9.5.2 Outdoor Stationary ESS Installations

Compliance Required	**Remote Locations**	**Locations Near Exposures**	**Reference**
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Clearance to exposures	NA	Yes	9.5.2.6.1
Means of egress separation	NA	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Vegetation control	Yes	Yes	9.5.2.2
Enclosures	Yes	Yes	4.6.12
Size and separation	No	Yes	9.4.2
Maximum stored energy	No	Yes	9.4.1
Smoke and fire detection	Yes	Yes	9.6.1

Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Toxic and highly toxic emissions	Yes	yes	9.6.7
~~Technology-specific protection~~ Exhaust Ventilation during normal operations*	Yes	Yes	9.6.5.1
Spill control*	Yes	Yes	9.6.5.2
Neutralization*	Yes	Yes	9.6.5.3
Safety caps*	Yes	Yes	9.6.5.4
Thermal runaway*	Yes	Yes	9.6.5.5
Explosion control	Yes	Yes	9.6.5.6

NA: Not applicable.

* Table 9.6.5 shall determine if a sub-category of electrochemical ESS must comply with this requirement. The listed reference section shall determine whether the form-factor of an ESS defined in 3.3.9 shall comply or is exempt from this requirement.

First Revision Text (FR)	
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions. As the technology Specific protection table changes with the changes in technology and batter type, the applicable code requirements for location specific application is not always clear. The specific mitigation measures are added to the tables for guidance per locations.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

<table>
<tr><td>A.9.6.5.1</td><td>38</td><td></td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.9.6.5.1
This section addresses hazards associated with the release of flammable gases from ESS during normal charging, discharging, and use conditions. Similar requirements have been in fire codes for many years primarily to address off-gassing of hydrogen from stationary vented lead-acid battery systems but not limited to that technology.
This section is not intended to provide protection against the release of flammable gases during abnormal charging or thermal runaway conditions. Those conditions are addressed in 9.6.5.6. In addition, this section does not regulate ventilation of toxic and highly toxic ~~gases~~ emissions, which are regulated by 4.6.11.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">A.9.6.5.1
This section addresses hazards associated with the release of flammable gases from ESS during normal charging, discharging, and use conditions. Similar requirements have been in fire codes for many years primarily to address off-gassing of hydrogen from stationary vented lead-acid battery systems but not limited to that technology.
This section is not intended to provide protection against the release of flammable gases during abnormal charging or thermal runaway conditions. Those conditions are addressed in 9.6.5.6. In addition, this section does not regulate ventilation of toxic and highly toxic ~~gasses~~ emissions, which are regulated by 4.6.11.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New 9.6.5.1.2.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>39</td><td></td><td>☐~~☒~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.1.2 **Abnormal Conditions.**
Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6.
9.6.5.1.2.2 Protection against toxic or Highly toxic emissions during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.7</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.6.5.1.2.2 Protection against toxic or highly toxic emissions during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.7</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.</td></tr>
</table>

Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.6.7	40		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7* Abnormal Toxic and highly toxic emission detection Where required elsewhere in this standard, detection and protection shall be provided for toxic and highly toxic emission during abnormal charging or thermal runaway in accordance with this section. A.9.6.7 During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS, in particular electrochemical batteries and capacitors, begin producing toxic and highly toxic emissions, which can include mixtures of CO, H2, ethylene, methane, benzene, HF, HCl, sulfur dioxide, NO, NO_2, ammonia, hydrogen sulfide, arsine, stibine, formaldehyde, metal oxides, heavy metals, and HCN, etc. Among other things, these emissions can present a health hazard that needs to be addressed. Toxic emissions almost always necessitate the use of SCBA (and possibly additional PPE) for anyone getting near a battery fire. At a bare minimum, sensing for toxic gases expected from the failure of the particular type of ESS should be done with permanent or portable equipment before entering the area without SCBA. Toxic emissions from the battery failure also necessitate the use of appropriate PPE during cleanup later on after first response.		

First Revision Text (FR)	9.6.7* Abnormal Toxic and highly toxic emission detection Detection and protection shall be provided for toxic and highly toxic emission during abnormal charging or thermal runaway where required by the HMA and based on large scale fire testing in accordance with this section and Tables 9.5.1, 9.5.2, 9.5.3.1, 9.5.3.2.6. A.9.6.7 During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS, in particular electrochemical batteries and capacitors, begin producing toxic and highly toxic emissions, which can include mixtures of CO, H2, ethylene, methane, benzene, HF, HCl, sulfur dioxide, NO, NO_2, ammonia, hydrogen sulfide, arsine, stibine, formaldehyde, metal oxides, heavy metals, and HCN, etc. Among other things, these emissions can present a health hazard that needs to be addressed. Toxic emissions almost always necessitate the use of self-contained breathing apparatus (SCBA) and possibly additional PPE for anyone getting near a battery fire. At a bare minimum, sensing for toxic gases expected from the failure of the particular type of ESS should be done with permanent or portable equipment before entering the area without SCBA. Toxic emissions from the battery failure also necessitate the use of appropriate PPE during cleanup later on after first response.		
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			
New 9.6.7.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	41	None	☐~~☒~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7.1 Protection against the release of toxic and highly toxic gas emission during normal operation shall be in accordance with 4.6.11.		
First Revision Text (FR)	9.6.7.1 Protection against the release of toxic and highly toxic gas emission during normal operation shall be in accordance with 4.6.11.		
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for			

not making some changes or for resolving)			
New 9.6.7.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	42	None	☐~~☒~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7.2 * Where toxic gas detection is used to provide evacuation notice and/or first responder alert, the detection system shall comply with the following: 1. The gas detection system shall be designed to provide a warning when the sensed gas(es) reaches the TWA REL. 2. The gas detection system shall provide an audible alarm when the sensed gas(es) reaches 25 percent of the IDLH. 3. The gas detection system shall be provided with a minimum of 2 hours of standby power. 4. For lithium-ion batteries, the gas detection system shall be provided with a minimum of 24 hours of standby power and 2 hours in alarm or as required by the HMA. 5. The gas detection system shall annunciate the following at an approved central, proprietary, or remote station in accordance with NFPA 72, or at an approved constantly attended location: a. A trouble signal upon failure of the gas detection system b. An alarm signal if the sensed toxic gas(es) concentration exceeds the TWA REL A.9.6.7.2 The decision as to whether to install a permanent toxic gas detection system is usually dependent on the technology, its likelihood to go into thermal runaway, and whether the site is remote or occupied (or presents an exposure hazard to those who may work, live, or pass nearby). Which toxic gas(es) to detect is dependent on the ESS technology. All of these decisions can be informed by ensuring that any UL 9540A testing done includes the quantities of expected toxic gases emitted to the environment. In addition, plume studies to determine exposure distances, and indoor air quality studies for those technologies that will be placed indoors can inform the analysis. All of these elements would go into an HMA and need review by a fire protection engineer to guide both the system/site designer(s) and the AHJ.		

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.6.7.2 *
Where toxic gas detection is used to provide evacuation notice and/or first responder alert, the detection system shall comply with the following:
1. The gas detection system is designed to provide a warning when the sensed gas(es) reaches the TWA REL.
2. The gas detection system provides an audible alarm when the sensed gas(es) reaches 25 percent of the IDLH.
3. The gas detection system is provided with a EPSS or SEPSS in accordance with Section 4.10
4. The gas detection system annunciates the following at an approved central, proprietary, or remote station in accordance with NFPA 72, or at an approved constantly attended location:
a. A trouble signal upon failure of the gas detection system
b. An alarm signal if the sensed toxic gas(es) concentration exceeds the TWA REL
A.9.6.7.2
The decision as to whether to install a permanent toxic gas detection system is usually dependent on the technology, its likelihood to go into thermal runaway, and whether the site is remote or occupied (or presents an exposure hazard to those who may work, live, or pass nearby). Which toxic gas(es) to detect is dependent on the ESS technology. All of these decisions can be informed by ensuring that any UL 9540A testing done includes the quantities of expected toxic gases emitted to the environment. In addition, plume studies to determine exposure distances, and indoor air quality studies for those technologies that will be placed indoors can inform the analysis. All of these elements would go into an HMA and need review by a fire protection engineer to guide both the system/site designer(s) and the AHJ.
9.6.7.2.1 Other technologies used for detection and notification shall be evaluated by a registered design professional with experience in fire protection for appropriate use per the HMA.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Power requirements are added as new Section 4.10 to cover all EPSS requirements.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New 9.6.7.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>43</td><td>None</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.7.3*
The test report shall be accompanied by a supplemental report prepared by a registered design professional with expertise in fire protection engineering that provides interpretation of the test data in relation to the installation requirements for the ESS</td></tr>
</table>

	A.9.6.7.3 It is recommended that the effects of toxic emissions are considered where there are significant exposures to nearby populations. Plume models can be used to determine potential consequences for scenarios of interest. Plume models should be selected based on appropriate scenarios derived from experimental data. Model outputs must be presented in a way that they can be used to efficiently address the hazards of concern (i.e., toxicity and flammability).		
First Revision Text (FR)	9.6.7.3* The test report shall be accompanied by a supplemental report prepared by a registered design professional with expertise in fire protection engineering that provides interpretation of the test data in relation to the installation requirements for the ESS. A.9.6.7.3 It is recommended that the effects of toxic emissions be considered where there are significant exposures to nearby populations. Plume models can be used to determine potential consequences for scenarios of interest. Plume models should be selected based on appropriate scenarios derived from experimental data. Model outputs must be presented in a way that they can be used to efficiently address the hazards of concern (i.e., toxicity and flammability).		
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			
New 9.6.7.4	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	44	None	☒ ☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7.4* toxic and highly toxic emission detection shall not be required based on fire and explosion testing in accordance with 9.1.5 and a plume study demonstrating that toxic and highly toxic emission concentrations cannot exceed 25% IDLH. A.9.6.7.4 About Plume Models: Plume modeling is performed to determine the dispersion extents of flammable and toxic vent gases or products of combustion. Plume models may be required by a utility, customer or AHJ to provide information about possible consequences of a release of material. Plume models may be used to understand potential first responder exposures, inform emergency response planning and/or provide information about potential environmental consequences. Plume models can inform minimum approach distance (MAD) and safe staging area locations. Plume Modeling Methodology: A plume model will provide information on possible events based on possible incidents and weather conditions. Since incidents may have unique failures and occur in varied weather conditions, plume studies do not determine the precise outcome of a specific event. Modeling should be performed using accepted plume modeling tools or computational fluid dynamics models and should evaluate the impact of wind and environmental conditions on the results. Source Term:		

	The selection of scenarios should be based on the most likely failure conditions as well as the highest consequence failure conditions that are reasonably expected to occur. The model should consider dispersion created by a forced ventilation system that may be installed for NFPA 69 purposes. Source term modeling should take into account the temperature of the gases and the heat release rate of a fire. Depending on expected failure conditions, separate plume models may need to be created to consider fire and non-fire conditions. Plume modeling should include something similar to a probable worst-case scenario, which can be used for emergency planning. Weather Conditions Plume model results depend on weather conditions at the time of release. Plume models should use reasonable worst-case weather conditions based on historical weather conditions at the site. Alternatively worst-case conditions of wind at 10m at 1.5 m/s and class F stability may be used. Plume Model Outputs: The modeling should clearly show the extent of any hazardous exposures under varying wind conditions and identify any potential consequences extending outside project boundaries. For toxicity, the model output should provide the toxic gas components (or an equivalent toxic gas mixture) in ppm as function of distance from the source and time. For flammability, the model output should provide the flammable gas mixture in percent of LFL as function of distance from the source and time. Cloud shapes may be plotted for fixed values of toxic concentration and flammable concentration to identify hazardous areas and areas where ignition source control may be needed, respectively. Appropriate elevations shall be selected for model output given the objective of the analysis. For example, providing gas concentrations at 6-feet elevation may be appropriate when evaluating first responder safety whereas ground level concentrations may be appropriate for environmental assessments. First responder use of plume studies: A plume study can be great information for first responders. Similar to structure fire size-up to “read the smoke”, the plume and hazards related to the battery event will help identify the level of hazard on initial arrival. A worst case most probable scenario provides a starting point for monitoring and consideration for protective action. Ideally, the design basis failure should not require protective actions for the public located beyond the property line of the facility unless with prior approval by the AHJ. When the AHJ approves release levels that may require protective actions based on the design basis plume study, an Annex shall be added to the regional emergency operating plan to address this hazard. Monitoring The plume model will help first responders identify starting points for immediate and follow-up monitoring. First responders should monitor for CO, LFL, and HF at a minimum. CO is most common and easier to detect airborne effluents. As battery chemistry changes the toxic material may change but CO and LFL should be monitored in all cases. Minimum Approach Distance Plume models may be used to inform the MAD to be used for emergency incidents. The MAD should be at a distance at which the concentrations generated by the plume are not expected to exceed IDLH or AEGL-2 values for 60-minute exposure. If the incident is expected to last a long time, then the concentration could be based on longer time period exposures and the distance may be increased.
First Revision Text (FR)	9.6.7.4* Toxic and highly toxic emission detection shall not be required based on fire and explosion testing in accordance with 9.1.5 and a plume study demonstrating that toxic and highly toxic emission concentrations cannot exceed 25% IDLH. A.9.6.7.4 About Plume Models: Plume modeling is performed to determine the dispersion extents of flammable and toxic vent gases or products of combustion. Plume models may be required by a utility, customer or AHJ to provide information about possible consequences of a release of material. Plume models may be used to understand potential first responder exposures, inform emergency response planning and/or provide information about potential environmental consequences. Plume models can inform minimum approach distance (MAD) and safe staging area locations.

Plume Modeling Methodology:

A plume model may provide information on possible events based on possible incidents and weather conditions. Since incidents may have unique failures and occur in varied weather conditions, plume studies do not determine the precise outcome of a specific event.

Modeling should be performed using accepted plume modeling tools or computational fluid dynamics models and should evaluate the impact of wind and environmental conditions on the results.

Source Term:

The selection of scenarios should be based on the most likely failure conditions as well as the highest consequence failure conditions that are reasonably expected to occur. The model should consider dispersion created by a forced ventilation system that may be installed for NFPA 69 purposes. Source term modeling should take into account the temperature of the gases and the heat release rate of a fire. Depending on expected failure conditions, separate plume models may need to be created to consider fire and non-fire conditions. Plume modeling should include something similar to a probable worst-case scenario, which can be used for emergency planning.

Weather Conditions

Plume model results depend on weather conditions at the time of release. Plume models should use reasonable worst-case weather conditions based on historical weather conditions at the site. Alternatively worst-case conditions of wind at 10m at 1.5 m/s and class F stability may be used.

Plume Model Outputs:

The modeling should clearly show the extent of any hazardous exposures under varying wind conditions and identify any potential consequences extending outside project boundaries. For toxicity, the model output should provide the toxic gas components (or an equivalent toxic gas mixture) in ppm as function of distance from the source and time. For flammability, the model output should provide the flammable gas mixture in percent of LFL as function of distance from the source and time. Cloud shapes may be plotted for fixed values of toxic concentration and flammable concentration to identify hazardous areas and areas where ignition source control may be needed, respectively. Appropriate elevations should be selected for model output given the objective of the analysis. For example, providing gas concentrations at 6-feet elevation may be appropriate when evaluating first responder safety whereas ground level concentrations may be appropriate for environmental assessments.

First responder use of plume studies:

A plume study can be great information for first responders. Similar to structure fire size-up to “read the smoke”, the plume and hazards related to the battery event may help identify the level of hazard on initial arrival. A worst case most probable scenario provides a starting point for monitoring and consideration for protective action. Ideally, the design basis failure should not require protective actions for the public located beyond the property line of the facility unless with prior approval by the AHJ. When the AHJ approves release levels that may require protective actions based on the design basis plume study, an annex should be added to the regional emergency operating plan to address this hazard.

Monitoring

The plume model will help first responders identify starting points for immediate and follow-up monitoring. First responders should monitor for CO, LFL, and HF at a minimum. CO is most common and easier to detect airborne effluents. As battery chemistry changes the toxic material may change but CO and LFL should be monitored in all cases.

Minimum Approach Distance

Plume models may be used to inform the MAD to be used for emergency incidents. The MAD should be at a distance at which the concentrations generated by the plume are not expected to exceed IDLH or AEGL-2 values for 60-minute exposure. If the incident is expected to last a long time, then the concentration could be based on longer time period exposures and the distance may be increased.

Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			
New 9.6.7.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	45	None	☒ ☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7.5 A plume study shall not be required for outdoor remote locations.		
First Revision Text (FR)	9.6.7.5 A plume study shall not be required for outdoor remote locations.		
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			
New 9.6.7.6	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	46	None	☒ ☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.7.6 Toxic and highly toxic emission detection shall not be required for the following: (1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 (2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations (3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units (4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 (5) Batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test		

First Revision Text (FR)	9.6.7.6 Toxic and highly toxic emission detection shall not be required for the following: (1) Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 (2) Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations (3) Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, and housed in a single cabinet in a single fire area in buildings or walk-in units (4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 (5) Batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell level test or equivalent test
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. The addition of a new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
15.10	156	~~48~~	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	15.10 ESS Toxic ~~and Highly Toxic~~ Gas Release During Normal Use. ESS that have the potential to release toxic ~~or highly toxic~~ gas during charging, discharging, and normal use conditions shall be installed outdoors.		
First Revision Text (FR)			
Statement (technical reason for FR)	As the requirements and definition for toxic and highly toxic are different it is appropriate to define both. Retaining both terms provides consistency with the rest of the document.		
Response (technical reason for not making some changes or for resolving)			

15.10	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	48	~~156~~	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.10 ESS Toxic and Highly Toxic Gas ~~Release~~ Emissions During Normal Use. ESS that have the potential to release toxic or highly toxic ~~gas~~ emissions during charging, discharging, and normal use conditions shall be installed outdoors.		
First Revision Text (FR)	15.10 ESS Toxic and Highly Toxic Gas ~~Release~~ Emissions During Normal Use. ESS that have the potential to release toxic or highly toxic ~~gas~~ emissions during charging, discharging, and normal use conditions shall be installed outdoors.		
Statement (technical reason for FR)	Information on the generation and emission of gases is still limited. A new section addresses a path to evaluate toxic and highly toxic gas and requirements to mitigate potential emission of gases during failure conditions.		
Response (technical reason for not making some changes or for resolving)			

Chapter 16 Energy Storage Systems on Barges and Vessels

16.1 Application.

16.1.1* The requirements of this chapter shall apply to installations of ESS on marine barges, vessels, and ships that are used to provide power to electrical loads that are external to the barge, vessel or ship.

A.16.1.1 The intent of this section is to provide minimum safety requirements for ESS on marine vessels that may become mobile to provide power to electrical loads on adjacent land based facilities, other moored vessels, or off-shore structures such as oil drilling platforms. In the event that the provisions of chapter 16 do not adequately cover the installation and operation requirements for these systems, the *Design Guidance for Lithium-ion Battery Installations Onboard Commercial Vehicles* CG-ENG-Policy Letter Dated 02-19 may be utilized as a reference. In the event of conflicting requirements between the provisions of this standard and the reference, the more stringent requirements shall be implemented. This shall include the ASTM F3353-19: Standard Guide for Shipboard Use of Lithium-Ion (Li-ion) Batteries

16.1.2. Unless modified by this chapter, the requirements of Chapters 1 through 14 shall also apply.

Compliance Required	Barge	Reference
Administrative	Yes	Chapters 1–3
General	Yes	Sections 4.1–4.7
Maximum size	Yes	9.5.2.4
Means of egress separation	Yes	9.5.2.6.1.7
Dedicated Use Buildings	Yes	9.5.1.1
Enclosures	Yes	4.6.12
Clearance to exposures	Yes	9.5.3.1.3
Fire suppression and control	Yes	9.5.3.1.4
Size and separation	Yes	9.4.2
Maximum stored energy	Yes	9.4.1
Elevation	Yes	4.7.7
Smoke and fire detection	Yes	9.6.1
Signage	Yes	4.7.4
Occupied work centers	Yes*	9.5.1.2.1
Open rack installations	Yes	4.7.9
Technology-specific protection	Yes	9.6.5
Other Technology	Yes	Chapter 10-13
Storage (off-spec)	Yes	Chapter 14
Stacking[N]	Yes	Chapter 16
Commissioning, Decommissioning	Yes	Chapters 6 and 8
Maintenance and operation	Yes	Chapter 7

NA: Not applicable.

[N] New addition

**NOTE – TOXICS TO BE ADDED IN FUTURE – 1st revisions and cross referencing

~~16.2 Declared disasters~~

~~**16.2.1*** Where the ESS covered by this chapter are deployed to provide power in areas where disasters have been declared by governmental authorities, the AHJ is authorized to temporarily suspend the application of requirements in this standard for an approved time duration.~~
~~**A.16.2.1** In situations where natural or other disasters occur in communities, these ESS may be required to provide power that is critical to the health and safety of the local population. In these emergency situations the AHJ may choose to get power restored as soon as possible. A plan and timetable can then be developed to apply additional requirements of this standard on a staged basis.~~

16.3 Commissioning, recommissioning and decommissioning

16.3.1* ESS commissioning, recommissioning, and decommissioning shall comply with this standard.

A.16.3.1 Since the ESS covered by this section can be deployed on a temporary basis, the AHJ may determine compliance with these requirements based on documentation approved by AHJs in other jurisdictions during a previous deployment. (check Mobile requirements – Make sure this is consistent).

16.4 Operations and maintenance

16.4.1 Operations and maintenance manuals shall be provided and available as required in 6.3.

Consideration of the impact of salt water and corrosive environments shall be taken into account when developing testing, maintenance, and inspection procedures.

16.5 Emergency Planning and Training.

16.5.1 Emergency planning and training shall be provided in accordance with 4.3.

16.5.2* Emergency planning and training shall take into consideration:

1) All safety considerations associated with potential ESS events of land based ESS installations
2) * Alternate protection means provided for the installation, and
3) * Response considerations and practical difficulties associated with the marine environment at the deployment site and during transit.
4) * Evacuation of personnel from the vessel during emergency situations.

A.16.5.2(2) The emergency response training and pre-planning should include the unique hazards of floating ESS including but not limited to:

1. Water supply that may be associated with fire protection systems.
2. Locations of E-Stops and accessibility, including while vessel is in transit.
3. Operation of E-stops and functionality, including interconnection to distributed generation sources, and potential impact to back-up power of fire protection systems.
4. Operation of Critical radio communications and location tracking systems, with redundant back-up power.
5. Corrosion protection~~ – ~~Corrosive environment protection.
6. Shore connections for Fire Protection systems, including potential flex connections for barge movement with stationary hard piping for the Fire Department Connections.
7. Water application of varying salinity (Salt water, fresh water, brackish) and potential negative effects of saltwater application to equipment.
8. Transformers and transformer related hazards.
9. Thermal management of systems and safety components (temperature control).
10. Impact of stray current from batteries on to marina or responding emergency vessels.
11. Impacts from the full extent of tidal surges on Fire Department response and capabilities.
12. Ship in distress and designation of Captain of Port to take charge during an emergency situation.

A.16.5.2(3) Guidelines and standards are available that cover emergency response considerations and tactics related to these ESS deployments. These include the following:

The *NFPA 1405 Guide for Land-Based Fire Departments That Respond to Marine Vessel Fires* identifies the elements of a comprehensive marine fire-fighting response program including, but not limited to, vessel familiarization, training considerations, pre-fire planning, and special hazards that enable land-based fire fighters to extinguish vessel fires safely and efficiently. In general, the practices recommended in this publication apply to vessels that are covered by the Safety of Life at Sea (SOLAS) agreement or that call at United States ports. It does not consider offshore terminals or vessels on the high sea.

The *NFPA 1005 Standard for Professional Qualifications for Marine Fire Fighting for Land-Based Fire Fighters* specifies the minimum job performance requirements for Land-Based Fire Fighters operating at marine fire-fighting incidents. It does not address organization/ management responsibility.

The *NFPA 1660 Standard for Emergency, Continuity, and Crisis Management: Preparedness, Response, and Recovery* provide fundamental criteria for all-hazards preparedness, response, and resiliency program management; the fundamental criteria for mass evacuation, sheltering, and re-entry program management; and a process for the development of pre-incident plans to assist personnel with safe and effective incident management.

A.16.5.2(4) The *NFPA 301 Code for Safety to Life from Fire on Merchant Vessels* addresses construction, arrangement, protection, and space utilization factors that are necessary to minimize danger to life from fire, smoke, fumes, or panic. It ~~also~~ provides for reasonable protection against property damage and avoidance of environmental damage consistent with the normal operation of vessels. It also identifies the minimum criteria for the design of egress facilities so as to permit prompt escape of passengers and crew to safe areas aboard vessels and, where necessary, to survival craft embarkation stations.

16.6 Locations, anchoring, and securement

16.6.1* The locations in which ESS covered by this section are deployed or staged shall be approved by the AHJ.

A.16.6.1 Consideration should be given to the location in which the ESS is to be deployed, or staged prior to deployment so that adequate distance is provided between the ESS and exposures. In marine deployments nearby marine traffic may represent an exposure or potential risk and should be taken into consideration.

16.6.2 The methods used to anchor or moor the vessel containing the ESS in place shall be approved and provided in accordance with recognized ~~practices, and~~practices and take into consideration wave action and tidal surges.

16.6.3 When vessels /barges are transported and maintained at a Dry-dock facility for maintenance and inspection, the State of Charge shall be reduced and ~~limited to a minimum of~~maintained to a ~~S~~tate of Charge of 30%, or lower as per manufacturer's specifications and recommendations.
** ADD - Temperature control/conditioning and maintenance of BMS protection data while dry docked. Location of Dry docking?

16.6.~~3~~ 4 An approved fence with a locked gate or other approved barrier shall be provided to keep the general public at least 10 ft (1.5 m) from the outer enclosure of the ESS.

16.7 Electrical connections

16.7.1 Approved temporary or fixed electrical connections shall be permitted to provide power to the electrical loads.

16.7.2* Temporary or fixed wiring for electrical power connections shall comply with NFPA 70, Manufacturer's requirements, and/ or equivalent codes or regulations.
A.16.7.2 If power is provided to marine related structures or vessels, marine related electrical regulations may take precedence.

16.7.3 A readily accessible disconnecting means for the ESS shall be provided in accordance with 5.2. Where required by the AHJ, disconnecting means shall be provided that are accessible both on the vessel, and on the shore or structure being supplied.

16.8 Marine environment

16.8.1* Equipment, wiring, and enclosure's UL 9540 listing~~s~~ shall ~~be~~ include the ability of the equipment to be installed in the intended Marine environment. ** C3, C5, C5 protection** Look up. Salt used in road causing corrosion – harsh on equipment. ~~suitable for use in the marine environment~~

A.16.8.1 This requirement is intended to ensure that equipment has sufficient seals, construction, and corrosion resistance to survive the marine environment in which it is used, which may include fresh water or salt water exposures, and potential immersion due to large waves or water spray. Paint protection should follow ISO 12944:2018 "Corrosion protection of steel structures by protective paint systems". System's provided with appropriate NEMA rating for water and corrosion resistance. Outside and inside box – Corrosion of failure and electronics within box.

16.8.2 Equipment, wiring and enclosures that have degraded due to exposure to the marine environment shall be repaired or replaced to provide the required protection.

16.9 Smoke and Fire Detection.

16.9.1 Systems used in required smoke and fire detection applications shall be suitable for use in the marine environment in which the vessel is deployed, *unless detectors and system are provided and entirely enclosed within adequately listed NEMA enclosure~~.~~ * (4X NEMA)

16.9.2 Where approved the smoke and fire detection systems that comply with maritime regulations shall be considered equivalent to the protection required by 4.8.

16.10 Fire Control and Suppression.

16.10.1 Systems used in required fire control and suppression applications shall be suitable for use in the marine environment in which the vessel is deployed.

16.10.2 Where approved fire control and suppression systems that comply with maritime regulations shall be considered equivalent to the protection required by 4.8.

16.11 Fire Protection and Construction for Marinas and Boatyards.

The design of Fire Protection systems for Marinas and Boatyards shall be governed by NFPA 303 and NFPA 307. Adequate setbacks and separation distances (or a passive means of protection) shall be provided between the barge/vessel and other barges/vessels or marina buildings and construction when moored.

16.12* Multi-leveled and Stacked Barges.

A Hazard Mitigation Analysis shall be conducted for Battery Barges utilizing multiple levels, stacked systems, or dedicated use structures of BESS. The HMA shall specifically address the unique impacts of these installation ~~orientations~~orientations.

A.16.12 The Hazard Mitigation Analysis should include the unique hazards of floating ESS utilizing stacked equipment, tiered structures, and dedicated use buildings including but not limited to:

1. Full-scale fire and fault testing (UL 9540A) to represent installation arrangement, with stacked systems.
2. For containers that are directly stacked without an interstitial structure, additional Full-scale fire testing (that shows visible external flaming and propagation) to address a fire event that will directly affect the stacked container above it or adjacent to it, or structural capacity of lower container, including impacts from Radiant heat and deflagration pressures. Hourly passive fire ratings (minimum 2-hr rating) resulting of full-scale failure testing or computer-based modeling that shows visible external flaming.
3. Passive fire protection (ratings) to protect structure from impact resulting from a ~~B~~BESS fire.
4. For stacked rooms or structures that are multiple levels; the impact and feasibility of explosion protection systems (deflagration venting and location of vents) and effectiveness of supporting structure.
5. The potential impact from wind driven events for systems utilizing Open sides (similar to open parking garages) or exposed BESS.
6. The location of Barge and exposures – Remote vs near exposures and impacts.
7. New Technologies if battery technologies not listed in Table 1.3.
8. An analysis of the impact to equipment inside Control House, including but not limited to protection systems and redundancy (backup power). Critical equipment may include Fire protection, Temperature Control (HVAC) and Battery management/Energy Management systems associated with Energy Storage Systems.
9. Minimum fire separations from Occupied or Occupiable spaces and BESS equipment. Adequate protection with rated assemblies for corridors and means of egress.

A16.1#* AHJ Approval Checklist

- **Fire Protection Design**
- **Permit Application**
- **Temporary Connections**
- **Expand on safety requirements**

Etc.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
1.3	181	221, 229	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

1.3* Application.

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

	Aggregate Capacity[a]	
ESS Technology	**kWh**	**MJ**
Battery ESS		
Lead-acid, all types	70	252
Ni-Cad, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium Metal	20	72
Nickel-Hydrogen	20	72
Zinc Bromide	20	72
Zinc Manganese Dioxide (Zn-MnO2)	20	72
Flow batteries[c]	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

First Revision Text (FR)

See below for revised text.

Statement (technical reason for FR)

The task group 8, received multiple presentations from various proposed new technology. Presentations ranged from product testing and comparison to like technology based on findings in testing. This first revision is intended to include the proposed new technologies to highlight lithium metal, nickel-hydrogen, zinc bromide, and zin manganese dioside in table 1.3. First revision and include the provisions of 221, 229, and 265

Response
(technical reason for not making some changes or for resolving)

1.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	221	181, 229	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	Aggregate Capacity[a]	
	kWh	**MJ**
Battery ESS		
Lead-acid, all types	70	252
Ni-C~~a~~d, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Flow batteries[c]	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

First Revision Text (FR)

See below for revised text.

Statement
(technical reason for FR)

The proposed PI 221 updates the correct terminology for NI-Cd Batteries and has be recommended change in table 1.3.

Response
(technical reason for not making some changes or for resolving)

1.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	229	181, 221	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	Aggregate Capacity[a]	
	kWh	**MJ**
Battery ESS		
Lead-acid, all types	70	252
Ni-C~~a~~d, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Flow batteries[c]	20	72
Iron-air	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

First Revision Text (FR)

See below for revised text.

Statement (technical reason for FR)

The task group received a presentation on Iron-Air battery technology. The preliminary test results presented to the committee identified similar response to other battery technologies. The task group would like additional testing infomraiton to be submitted by the applicant prior to the second revision as part of the public comment process.

Response (technical reason for not making some changes or for resolving)

1.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	265	181, 221, 229	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESS		
Lead-acid, all types	70	252
Ni-Cad, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Flow batteries[c]	20	72
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	70	252
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

First Revision Text (FR)

See below for revised text.

Statement (technical reason for FR)

The proposed language adds capacity requirements for Hybrid Supercapacitors with aggregate capacity similar to lithium ion batteries.

Response (technical reason for not making some changes or for resolving)

First Revision Text (FR)

1.3* Application.

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESS		
Lead-acid, all types	70	252
Ni-C~~a~~d, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Flow batteries[c]	20	72
Iron-air	20	72
Other battery technologies	10	36

Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESS		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	70	252
Other ESS		
All other ESS	70	252
Flywheel ESS (FESS)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.1.1	113	192, 357	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.7.1.1 Installations of ~~Lead~~ lead-acid and nickel-cadmium battery systems less than ~~50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under~~ 60 V dc that under the exclusive control of communications utilities ~~and~~ located outdoors or in building spaces used exclusively for such installations ~~that are in compliance with NFPA 76~~ shall not be required to comply with 4.7.1.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The task group felt this was previously covered and not sufficient clarification on the proposed change.		
4.7.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	192	113, 357	☐ Create First Revision ☒~~☐~~ Resolve

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.7.1.1
Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations ~~that are in compliance with NFPA 76~~ shall not be required to comply with 4.7.1.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">This was confusing to the task group as NFPA 76 was previously indicated as the standard and now it is recommended for deletion.</td></tr>
<tr><td>4.7.1.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>357</td><td>113, 192</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.7.1.1
Lead-acid~~ and ~~, nickel-cadmium, and zinc-manganese battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76 shall not be required to comply with 4.7.1.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Additional details should be submitted to justify the exception for zin maganes~~s~~e in this area.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.7.1.1
Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76 shall not be required to comply with 4.7.1.</td></tr>
</table>

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.1.2	359	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.7.1.2 Lead-acid~~ and~~ , nickel-cadmium, and zinc-manganese battery~~-~~systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.7.1.		
First Revision Text (FR)	4.7.1.2 Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.7.1.		
Statement (technical reason for FR)	The task group evaluated the proposal and found limited information on this proposed exception. Additional technical justification by the submitter to show equivalency or similar to the proposal.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.7.3	141	161 (different wording), 365	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.7.7.3 The requirements in 4.7.7 shall not apply to the following: (1) *Lead-acid and nickel-cadmium battery systems less than 50 V ac or 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 (2) *Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations (3) Lead-acid battery systems utilized exclusively in ~~uninterruptable~~ uninterruptible power supplies listed for their application and used for standby power applications, and limited to not more than 10 percent of the floor area on the floor on which the ESS is located (4) Lead-acid and Ni-cadmium battery systems listed to UL 1973.		

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">The task group evaluated the posed PI, and felt the language was not consistent to the section and did not provide the sufficient information that was already addressed in the three areas found in section 4.7.7.3</td></tr>
<tr><td rowspan="2">4.7.7.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>161</td><td>141 (different wording), 360</td><td>☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.7.7.3
The requirements in 4.7.7 shall not apply to the following:
(1) *Lead-acid and nickel-cadmium battery systems less than 50 V ac or 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76
(2) *Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations
(3) Lead-acid battery systems utilized exclusively in ~~uninterruptable~~ uninterruptible power supplies listed for their application and used for standby power applications, and limited to not more than 10 percent of the floor area on the floor on which the ESS is located
(4) Lead-acid and nickel-cadmium battery systems, which the batteries are listed to UL1973.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">4.7.7.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>360</td><td>141, 161</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
</table>

Proposed Text (PI)	4.7.7.3 The requirements in 4.7.7 shall not apply to the following: (1) *Lead-acid ~~and~~ , nickel-cadmium, and zinc-manganese battery systems less than 50 V ac or 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 (2) *Lead-acid ~~and~~ , nickel-cadmium, and zinc-manganese battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations (3) Lead-acid and zinc-manganese battery systems utilized exclusively in uninterruptable power supplies listed for their application and used for standby power applications, and limited to not more than 10 percent of the floor area on the floor on which the ESS is located
First Revision Text (FR)	See below for revised text
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	The task group evalualted the posed PI, and felt the language was not consistent to the section and did not provide the sufficient information that was already addressed in the three areas found in section 4.7.7.3
First Revision Text (FR)	4.7.7.3 The requirements in 4.7.7 shall not apply to the following: 1. *Lead-acid and nickel-cadmium battery systems less than 50 V ac or 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 2. *Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations 3. Lead-acid battery systems utilized exclusively in uninterruptable power supplies listed for their application and used for standby power applications, and limited to not more than 10 percent of the floor area on the floor on which the ESS is located

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.4.1	167	182, 231, 266	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy[a] (kWh)**
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Other battery technologies	200
Storage capacitors	20

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	Create FR Based on all items
Response (technical reason for not making some changes or for resolving)	

9.4.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	182	167, 231, 266	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy[a] (kWh)**
Lead-acid batteries, all types	Unlimited
Nickel batteriesb	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Other battery technologies	200
Storage capacitors	20

a For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000.

b Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn).

c Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	See below
Response (technical reason for not making some changes or for resolving)	

9.4.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	231	167, 182, 266	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy[a] (kWh)**
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600

Flow batteries[c]	600
Other battery technologies	200
Storage capacitors	20

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

9.4.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	266, 182, 167, 266	167, 182, 231	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy[a] (kWh)**
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Other battery technologies	200
Storage capacitors Hybrid supercapacitors	20 Unlimited

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000.

	[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn). [c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	The task group recommends a first revision by incorporating 167, 182, 231, and 266. The committee heard multiple proposals from various products which outlined a desire to be recognized in table 9.4.1 in a new ESS Type besides “other battery technologies.” The task group heard 7 presentations from various manufactures and evaluated the submitted information through the open task group process. The ESS line items added include Nickel-Hydrogen and Zinc Manganese Dioxide batteries which through submitted presentations indicated that through testing had little impact of fire through the various testing processes.. The task group is recommending that that material be recognized with an unlimited Maximum Stored Energy based on 9.4.1 The ESS line items are further recommended to be modified to include specific line items for Lithium Metal, and Zinc Bromide batteries with a maximum of 600 kWH. Through the presentation the submitted information by the various manufactures appeared the batteries performed above the hazards shown with Lithium-Ion.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	

9.4.1 Maximum Stored Energy.

ESS in the following locations shall comply with Section 9.4 as follows:

1. Fire areas within non-dedicated-use buildings containing ESS shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.
2. Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.
3. ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

4. Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-Hydrogen Batteries	Unlimited
Zinc Maganese Dioxide Batteries (ZN-Mno2)	Unlimited
Lithium-ion batteries, all types	600
Lithium Metal Batteries	600
Zinc Bromide Batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid Supercapacitors	Unlimited

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. . For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), and nickel zinc (Ni-Zn).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5	183	267, 292, 56	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Compliance Required

Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-Acid	Yes	Yes †	Yes †	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO2)	Yes	Yes †	Yes †	Yes	Yes	Yes
Zinc Bromide	Yes	Yes †	Yes †	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes †	Yes †	Yes	Yes	Yes
Nickel-Hydrogen	No	No	No	No	Yes	Yes
Lithium-Ion	No	No	No	No	Yes	Yes
Lithium Metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium Nickel Chloride	No	No	No	No	Yes	Yes
EDLC Energy Storage	Yes	Yes	Yes	Yes	Yes	Yes
Other Electrochemical ESS and Battery Technologies*	Yes	Yes	Yes	Yes	Yes	Yes

*The protection in this column is not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protection is not necessary based on the technology used.

†Applicable only to vented (e.g., flooded) batteries.

First Revision Text (FR)

If the decision is to use the table as reformatted by PI 183, make all Table 9.6.5 revisions to the PI text provided above. If the decision is to not use the reformatted table as a starting point, use the text provided below for revisions.

Statement (technical reason for FR)

Submit FR (Add to justin comment, or Lithium Ion Capacitors to lock in, need to add it in definition or in item

Lithium-Ion Capacitors (LIC)

Review PI 56 with Paul on Highly Toxic, our TG is looking at resolve PI 56. Concern over shutting down industry as no levels

Response (technical reason for not making

some changes or for resolving)

9.6.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	267	183, 292, 56	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

	Battery Technology			-		-			
Compliance Required	Lead-Acid	Ni-Cd, Ni-MH, Ni-Zn	Lithium-Ion	Flow	Sodium Nickel Chloride	Hybrid Supercapacitor	EDLC Energy Storage	Other Electrochemical ESS and Battery Technologies*	Reference
Exhaust ventilation	Yes	Yes	No	Yes	No	No	Yes	Yes	9.6.5.1
Spill control	Yes †	Yes †	No	Yes	No	No	Yes	Yes	9.6.5.2
Neutralization	Yes†	Yes†	No	Yes	No	No	Yes	Yes	9.6.5.3
Safety caps	Yes	Yes	No	No	No	No	Yes	Yes	9.6.5.4
Thermal runaway	Yes	Yes	Yes	No	Yes	No	Yes	Yes	9.6.5.5
Explosion control	Yes	Yes	Yes	No	Yes	No	Yes	Yes	9.6.5.6

*The protection in this column is not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protection is not necessary based on the technology used.

†Applicable only to vented (e.g., flooded) batteries.

First Revision Text (FR)

See above for revised text if using PI 183 reformatting. Otherwise, to create a FR, see below for revised text.

Statement (technical reason for FR)

Response (technical reason for not making

some changes or for resolving)	

9.6.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	292	183, 267, 56	☒☐ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Compliance Requirement	**Lead-Acid**	**Ni-Cd, Ni-MH, Ni-Zn**	**Lithium-Ion**	**Flow**	**Sodium Nickel Chloride**	**Iron-Air**	**EDLC Energy Storage**	**Other Battery Tech**	**Reference**
Exhaust Ventilation	Yes	Yes	No	Yes	No	Yes	Yes	Yes	9.6.5.1
Spill Control	Yes[1]	Yes[1]	No	Yes	No	Yes	Yes	Yes	9.6.5.2
Neutralization	Yes[1]	Yes[1]	No	Yes	No	Yes	Yes	Yes	9.6.5.3
Safety Caps	Yes	Yes	No	No	No	Yes	Yes	Yes	9.6.5.4
Thermal Runaway	Yes	Yes	Yes	No	Yes	No	Yes	Yes	9.6.5.5
Explosion Control	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	9.6.5.6

First Revision Text (FR)	See above for revised text if using PI 183 reformatting. Otherwise, to create a FR, see below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

9.6.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	56	183, 267, 292	☐ Create First Revision ☐ Resolve

Proposed Text (PI)

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Compliance Required	Battery Technology			-		-		
	Lead-Acid	Ni-Cd, Ni-MH, Ni-Zn	Lithium-Ion	Flow	Sodium Nickel Chloride	EDLC Energy Storage	Other Electrochemical ESS and Battery Technologies*	Reference
Exhaust ventilation	Yes	Yes	No	Yes	No	Yes	Yes	9.6.5.1
Spill control	Yes †	Yes †	No	Yes	No	Yes	Yes	9.6.5.2
Neutralization	Yes†	Yes†	No	Yes	No	Yes	Yes	9.6.5.3
Safety caps	Yes	Yes	No	No	No	Yes	Yes	9.6.5.4
Thermal runaway	Yes	Yes	Yes	No	Yes	Yes	Yes	9.6.5.5
Explosion control	Yes	Yes	Yes	No	Yes	Yes	Yes	9.6.5.6
Toxic and Highly Toxic emmission	Yes†	Yes	Yes	Yes	Yes	No	Yes	9.6.7

*The protection in this column is not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protection is not necessary based on the technology used.

†Applicable only to vented (e.g., flooded) batteries.

First Revision Text (FR)	See above for revised text if using PI 183 reformatting. Otherwise, to create a FR, see below for revised text.
Statement (technical reason for FR)	These pI's start with a change in the x and y access as part of PI 183. The task group felt it added usability to the table. The first revision further includes additional PI's for adding Iron Air, and Hybrid Supercapacitors. For reference, PI 56 was covered by another task group and will need to be reported out.
Response (technical reason for not making some changes or for resolving)	Not covered by this committee, Paul indicated this was picked up by the toxic commitee
First Revision Text (FR)	If the decision is to use the table as reformatted by PI 183, make all Table 9.6.5 revisions to the PI 183 text provided above. If the decision is to not use the reformatted table as a starting point, use the text provided below for revisions. (Yes use PI 183)

~~9.6.5 Technology-Specific Requirements.~~

~~Electrochemical ESS shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.5.~~

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Compliance Required						
Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-Acid	Yes	Yes †	Yes †	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO2)	Yes	Yes †	Yes †	Yes	Yes	Yes
Zinc Bromide	Yes	Yes †	Yes †	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes †	Yes †	Yes	Yes	Yes
Nickel-Hydrogen	No	No	No	No	Yes	Yes
Lithium-Ion	No	No	No	No	Yes	Yes
Lithium Metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium Nickel Chloride	No	No	No	No	Yes	Yes
Iron Air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies*	Yes	Yes	Yes	Yes	Yes	Yes

*The protection in this column is not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protection is not necessary based on the technology used.

†Applicable only to vented (e.g., flooded) batteries.

~~Compliance Required~~	~~Battery Technology~~				-	-	~~Other Electrochemical ESS and Battery Technologies*~~	~~Reference~~
	~~Lead-Acid~~	~~Ni-Cd, Ni-MH, Ni-Zn~~	~~Lithium-Ion~~	~~Flow~~	~~Sodium Nickel Chloride~~	~~EDLC Energy Storage~~		
~~Exhaust ventilation~~	~~Yes~~	~~Yes~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~Yes~~	~~9.6.5.1~~
~~Spill control~~	~~Yes †~~	~~Yes †~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~Yes~~	~~9.6.5.2~~
~~Neutralization~~	~~Yes†~~	~~Yes†~~	~~No~~	~~Yes~~	~~No~~	~~Yes~~	~~Yes~~	~~9.6.5.3~~
~~Safety caps~~	~~Yes~~	~~Yes~~	~~No~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~	~~9.6.5.4~~
~~Thermal runaway~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~	~~9.6.5.5~~
~~Explosion control~~	~~Yes~~	~~Yes~~	~~Yes~~	~~No~~	~~Yes~~	~~Yes~~	~~Yes~~	~~9.6.5.6~~

~~*The protection in this column is not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protection is not necessary based on the technology used.~~
~~†Applicable only to vented (e.g., flooded) batteries.~~

<table>
<tr><td>Section</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>15.5</td><td>342</td><td>106, 343, 154, 117, 155, 118</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">15.5 Energy Ratings.
15.5.1
Individual ESS units shall have a maximum ~~stored energy~~ rating of 20 kWh.
15.5.2
The ~~aggregate rating~~ ratings of the ESS in each location shall not exceed the ratings in Table 15.5.2. ~~following for each location listed:~~
~~(1) 40 kWh within utility closets, basements, and storage or utility spaces~~
~~(2) 80 kWh in attached or detached garages and detached accessory structures~~
~~(3) 80 kWh where outdoor wall mounted~~
~~(4) 80 kWh where outdoor ground mounted~~
15.5.3
The total aggregate ratings of ESS on the property shall not exceed 600 kWh.
15.5.~~3~~4
ESS installations exceeding the individual or aggregate ratings allowed by 15.5.1 or 15.5.2 through 15.5.3 shall comply with Chapters 4 through 9.
15.5.~~4*~~5 The use of an electric-powered vehicle to power the dwelling while parked shall comply with Section 15.11.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Where is attachment, need the table? (need tables to match). Task group 5 put in a 50kwh rating for fire barriers (coordination needed)</td></tr>
<tr><td>15.5.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
</table>

	106	342, 343	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	15.5.1 Individual ESS units using technologies other than lead-acid, Ni-Cd, Ni-Zn, Ni-MH, and NaNiCl shall have a maximum stored energy of 20 kWh.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	If there are higher limits in other places we should match. Are we okay with limits of 1.3? (First Revision)		
15.5.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	343	106, 342	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	15.5.1 Individual ESS units shall have a maximum ~~stored energy of 20 kWh.~~ rating based on its listing.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The task group was looking for additional ifnrmation on how the listing data would provide sufficient information. Not sufficient technical data submitted based on listing alone in the residential setting.		
New 15.5.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	154,	342	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.5.1.1 Unit sizing for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted.		
First Revision Text (FR)	See below for revised text.		

Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	Tie into first revision, a bit more then 106….. tie in to that (take technologies in 106 listed into this subsection		
15.5.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	117	342, 155	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	15.5.2 The aggregate rating of the ESS shall not exceed the following for each location listed: (1) 40 kWh for Li-based batteries, flow batteries, electric double-layer capacitors (EDLC), or battery types not listed in this requirement within utility closets, basements, and storage or utility spaces (2) 80 kWh for Li-based or flow batteries, EDLC, or battery types not listed in this requirement in attached ~~or detached~~ garages ~~and detached accessory structures~~, or ~~(3) 80 kWh~~ where outdoor wall-mounted to the primary residential structure, or when on or in accessory structures (such as detached garages, sheds) or ground-mounted within 10 feet of the primary residential structure (4~~3~~) 250 ~~80~~ kWh for Li-based or flow batteries or EDLC or battery types not listed in this requirement where outdoor ground mounted or on or in accessory structures 10 feet or more away from the primary residential structure (4) 250 kWh regardless of location on the residential property when using lead-acid, Ni-Cd, Ni-MH, Ni-Zn, NaNiCl, or rechargeable zinc manganese dioxide technologies		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	TG is ok with 250 kwH in item 3, the verbiage as submitted is confusing. TG recommends a revision to be a positive statement with charging statement in the various locations. (see work on PI 155)		
15.5.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	155	342, 117	☒~~☐~~ Create First Revision ☐ Resolve

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">15.5.2
The aggregate rating of the ESS shall not exceed the following for each location listed:
(1) 40 kWh within utility closets, basements, and storage or utility spaces
(2) 80 kWh in attached or detached garages and detached accessory structures
(3) 80 kWh where outdoor wall mounted
(4) 80 kWh where outdoor ground mounted.
(5) 250 kWh for lead-acid and nickel cadmium installations regardless of placements.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The committee reviewed the various PI’s and recommended changes to 15.5. The first will add approvals for certain batteries installed per UL 1973 and the second adds an exception listing in 15.5.2</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">15.5.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>118</td><td>342</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">15.5.3
ESS installations of Li-based batteries, flow batteries or electric double-layer capacitors (EDLC) exceeding the individual or aggregate ratings allowed by 15.5.1 or 15.5.2 shall ~~comply with Chapters 4 through 9~~ be provided with a product-level evaluation by an approved qualified person with expertised in energy storage as a supplemental safety document to be used by the AHJ and the installing contractors.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">The task group evaluated pi 118 and felt this was duplicative text to the cyapter as a whole and could layer in confusion by the user.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">15.5 Energy Ratings.
15.5.1</td></tr>
</table>

	Individual ESS units shall have a maximum stored energy of 20 kWh. 15.5.1.1 Unit sizing for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted. 15.5.2 The aggregate rating of the ESS shall not exceed the following for each location listed: 1. 40 kWh within utility closets, basements, and storage or utility spaces 2. 80 kWh in attached or detached garages and detached accessory structures 3. 80 kWh where outdoor wall mounted 4. 80 kWh where outdoor ground mounted ~~4.~~5. (5) 250 kWh for lead-acid and nickel cadmium installations regardless of placements. 15.5.3 ESS installations exceeding the individual or aggregate ratings allowed by 15.5.1 or 15.5.2 shall comply with Chapters 4 through 9. 15.5.4* The use of an electric-powered vehicle to power the dwelling while parked shall comply with Section 15.11.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
B.3.2	99	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	B.3.2 Chemical Hazards. Under normal operating conditions, the potential exists for exposure to hazardous materials by workers in contact with the system for maintenance, repair, and replacement of systems. OSHA and NIOSH have guidelines on exposures to hazardous materials, including limits for workers that have the potential for exposure during normal operation maintenance, and so forth. Examples of chemical hazards are as follows: (1) *Liquid hazards*: (a) *Corrosive electrolytes*: Batteries with electrolytes in the range of pH ≤2 or ≥11.5 are considered corrosive (acid or caustic). This is an issue with systems with these electrolytes, where there can be a situation of leaks or spills during maintenance or normal operation. There should be measures for spill control,		

	and workers should have appropriate safe work procedures and protective clothing and equipment such as an eye wash station or safety shower to work around systems with these corrosive liquids. (b) *Toxic liquids*: The potential exists for exposure to toxic liquids during normal operating, servicing, and maintenance of some systems. Guidance for worker exposure to toxic liquids can be found in OSHA hazardous materials guidelines. Workers in contact with these systems need to be aware of potential hazards and have appropriate procedures and equipment/PPE to avoid these hazards. (2) *Oxidizers*: The potential exists for oxidizers to be present within the ESS. An oxidizer will increase the flammability potential of other materials. Annex G in NFPA 400 provides information on tests to classify an oxidizer material and identifies known oxidizing materials under their classifications. Annex G in NFPA 400 also provides guidance on safety measures to use when there are significant exposed quantities of known oxidizers, which can occur during normal maintenance conditions of certain ESS technologies that contain them. (3) *Gases — Toxic gases*: The potential exists for exposure to toxic gases under normal conditions of maintenance and service of some ESS systems. OSHA and NIOSH provide guidance for exposures, including permissible exposure limits (PEL), recommended exposure limits (REL) for exposure during an 8- or 10-hour workday, ceiling limits, which are the upper limit of a safe exposure, and IDLH, which represents concentrations that are immediately dangerous to life and health. (4) *Solids*: Water-reactive and toxic metals that might be contained in some battery technologies typically are not exposed during routine maintenance and servicing of these systems but can present issues under abnormal conditions. Batteries containing these hazardous materials should be marked with the NFPA 704 diamond hazard symbols.
First Revision Text (FR)	B.3.2 Chemical Hazards. Under normal operating conditions, the potential exists for exposure to hazardous materials by workers in contact with the system for maintenance, repair, and replacement of systems. OSHA and NIOSH have guidelines on exposures to hazardous materials, including limits for workers that have the potential for exposure during normal operation maintenance, and so forth. Examples of chemical hazards are as follows: 1. *Liquid hazards*: 1. *Corrosive electrolytes*: Batteries with electrolytes in the range of pH ≤2 or ≥11.5 are considered corrosive (acid or caustic). This is an issue with systems with these electrolytes, where there can be a situation of leaks or spills during maintenance or normal operation. There should be measures for spill control, and workers should have appropriate safe work procedures and protective clothing and equipment such as an eye wash station or safety shower to work around systems with these corrosive liquids. 2. *Toxic liquids*: The potential exists for exposure to toxic liquids during normal operating, servicing, and maintenance of some systems. Guidance for worker exposure to toxic liquids can be found in OSHA hazardous materials guidelines. Workers in contact with these systems need to be aware of potential hazards and have appropriate procedures and equipment/PPE to avoid these hazards.

	2. *Oxidizers*: The potential exists for oxidizers to be present within the ESS. An oxidizer will increase the flammability potential of other materials. Annex G in NFPA 400 provides information on tests to classify an oxidizer material and identifies known oxidizing materials under their classifications. Annex G in NFPA 400 also provides guidance on safety measures to use when there are significant exposed quantities of known oxidizers, which can occur during normal maintenance conditions of certain ESS technologies that contain them. 3. *Gases — Toxic gases*: The potential exists for exposure to toxic gases under normal conditions of maintenance and service of some ESS systems. OSHA and NIOSH provide guidance for exposures, including permissible exposure limits (PEL), recommended exposure limits (REL) for exposure during an 8- or 10-hour workday, ceiling limits, which are the upper limit of a safe exposure, and IDLH, which represents concentrations that are immediately dangerous to life and health. 4. *Solids*: Water-reactive and toxic metals that might be contained in some battery technologies typically are not exposed during routine maintenance and servicing of these systems but can present issues under abnormal conditions. Batteries containing these hazardous materials should be marked with the NFPA 704 diamond hazard symbols.
Statement (technical reason for FR)	Came from task group 20, on flow batteries, grab committee statement Added "and equipment such as an eye wash station or safety shower" and made no other changes. In the case of some batteries, electrolyte is managed at site and provisions for eye wash stations and safety showers should be considered in addition to protective clothing. Lead acid and flow batteries may have electrolyte added after installation.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
B.5.1.3	100	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	B.5.1.3 Zinc Air Flow Batteries. Hazard considerations for zinc air flow batteries under normal operating conditions are as follows: (1) *Fire hazards*: There is the potential for concentrations of hydrogen from the charged electrolyte if the area where the electrolyte tank(s) are located is not properly ventilated. However, this should be taken care of if the installation complies with the codes.		

	(2) *Chemical hazards*: They contain corrosive liquid that might present a safety concern under normal conditions if there is a need to handle/replenish the electrolyte as part of maintenance. (3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they have hazardous voltage and energy levels. Technicians should follow accepted maintenance and installation procedures when working on flow batteries. (4) *Stranded or stored energy hazards*: Not applicable. (5) *Physical hazards*: Not applicable. Hazard considerations for zinc air flow batteries under emergency/abnormal conditions are as follows: (1) *Fire hazards*: In the presence of electrolyte heating due to an abnormal condition occurring internally to the system or from an external source, there is the potential for concentrations of hydrogen from the charged electrolyte if the area where the electrolyte tank(s) are located is not properly ventilated. ~~With continued heating, the water will evaporate and any hydrogen production will diminish.~~ (2) *Chemical hazards*: There are large amounts of corrosives that can create a hazard if the containment fails. (3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) *Stranded or stored energy hazards*: Not applicable. (5) *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating, if there is insufficient pressure relief when the system is overheating and gas is generated, or if there is exposure to moving hazardous parts such as fans or exposed pump parts where guards might be missing.
First Revision Text (FR)	B.5.1.3 Zinc Air Flow Batteries. Hazard considerations for zinc air flow batteries under normal operating conditions are as follows: 1. *Fire hazards*: There is the potential for concentrations of hydrogen from the charged electrolyte if the area where the electrolyte tank(s) are located is not properly ventilated. However, this should be taken care of if the installation complies with the codes. 2. *Chemical hazards*: They contain corrosive liquid that might present a safety concern under normal conditions if there is a need to handle/replenish the electrolyte as part of maintenance. 3. *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they have hazardous voltage and energy levels. Technicians should follow accepted maintenance and installation procedures when working on flow batteries. 4. *Stranded or stored energy hazards*: Not applicable.

	5. *Physical hazards*: Not applicable. Hazard considerations for zinc air flow batteries under emergency/abnormal conditions are as follows: 1. *Fire hazards*: In the presence of electrolyte heating due to an abnormal condition occurring internally to the system or from an external source, there is the potential for concentrations of hydrogen from the charged electrolyte if the area where the electrolyte tank(s) are located is not properly ventilated. ~~With continued heating, the water will evaporate and any hydrogen production will diminish.~~ 2. *Chemical hazards*: There are large amounts of corrosives that can create a hazard if the containment fails. 3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. 4. *Stranded or stored energy hazards*: Not applicable. 5. *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating, if there is insufficient pressure relief when the system is overheating and gas is generated, or if there is exposure to moving hazardous parts such as fans or exposed pump parts where guards might be missing.
Statement (technical reason for FR)	Came from task group 20, on flow batteries, grab committee statement.
Response (technical reason for not making some changes or for resolving)	The last sentence has been deleted because it does not describe a hazard. This Public Input was submitted by the Flow Battery Task Group TG20.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
B.5.4	184	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	**B.5.4** Lithium Metal, Solid State Batteries — General Description. Lithium metal batteries employing liquid electrolytes have been developed for commercial use but have had safety and performance problems in the field.~~ These batteries have not been developed at this time for stationary battery energy storage.~~ Commercially available lithium metal batteries utilized for ESS do not employ liquid electrolytes. The current lithium metal technologies use solid polymer electrolytes, a lithium metal negative electrode and a metal oxide cathode such as vanadium oxide combined with lithium salt and polymer to		

	form a plastic composite. The SPE-type lithium metal batteries must be heated to about 140°F to 176°F (60°C to 80°C) in order to be activated. Hazard considerations for lithium metal batteries under normal operating conditions are as follows: (1) *Fire hazards*: There can be the potential for fire hazards depending on the cell architecture and amount of lithium metal utilized if there are defects within the cells or design issues with the controls that prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects. (2) *Chemical hazards*: Not applicable. (3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) *Physical hazards*: Not applicable. Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows: (1) *Fire hazards*: There can be the potential for thermal runaway if the batteries are not maintained at appropriate operating parameters as a result of abnormal conditions and if not evaluated for ability to prevent propagation due to latent defects. Also there might be fire hazards due to short-circuiting abnormal conditions. (2) *Chemical hazards*: The potential ~~exists~~ for exposure of water-reactive lithium metal is minimal due to the small amount of lithium metal utilized in a cell. Water application would still the method of extinguishment. (3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. (5) *Physical hazards*: Depending on the design of the system, the potential exists for physical overheating or if there is us parts such as fans where guards might be missing.
First Revision Text (FR)	**B.5.4** Lithium Metal, Solid State Batteries — General Description. Lithium metal batteries employing liquid electrolytes have been developed for commercial use but have had safety and performance problems in the field. ~~These batteries have not been developed at this time for stationary battery energy storage.~~ Commercially available lithium metal batteries utilized for ESS do not employ liquid electrolytes. The current lithium metal technologies use solid polymer electrolytes, a lithium metal negative electrode and a metal oxide cathode such as vanadium oxide combined with lithium salt and polymer to form a plastic composite. The SPE-type lithium metal batteries must be heated to about 140°F to 176°F (60°C to 80°C) in order to be activated. Hazard considerations for lithium metal batteries under normal operating conditions are as follows: 1. *Fire hazards*: There can be the potential for fire hazards depending on the cell architecture and amount of lithium metal utilized if there are defects within the cells or design issues with the controls that prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects. 2. *Chemical hazards*: Not applicable.

3. *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.
4. *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement.
5. *Physical hazards*: Not applicable.

Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows:

1. *Fire hazards*: There can be the potential for thermal runaway if the batteries are not maintained at appropriate operating parameters as a result of abnormal conditions and if not evaluated for ability to prevent propagation due to latent defects. Also there might be fire hazards due to short-circuiting abnormal conditions.
2. *Chemical hazards*: The potential for exposure of water-reactive lithium metal is minimal due to the small amount of lithium metal utilized in a cell. Water application would still the method of extinguishment.
3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.
4. *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken.
5. *Physical hazards*: Depending on the design of the system, the potential exists for physical
6. overheating or if there is us parts such as fans where guards might be missing.

B.5.4 Lithium Metal, Solid State Batteries — General Description.

Lithium metal batteries employing liquid electrolytes have been developed for commercial use but have had safety and performance problems in the field. ~~These batteries have not been developed at this time for stationary battery energy storage.~~ Commercially available lithium metal batteries utilized for ESS do not employ liquid electrolytes. The current lithium metal technologies use solid polymer electrolytes, a lithium metal negative electrode and a metal oxide cathode such as vanadium oxide combined with lithium salt and polymer to form a plastic composite. The SPE-type lithium metal batteries must be heated to about 140°F to 176°F (60°C to 80°C) in order to be activated.

1. Hazard considerations for lithium metal batteries under normal operating conditions are as follows:
2. *Fire hazards*: There can be the potential for fire hazards if there are defects within the cells or design issues with the controls that prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects.
3. *Chemical hazards*: Not applicable.

	4. *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. 5. *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. 6. *Physical hazards*: Not applicable. Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows: 1. *Fire hazards*: There can be the potential for thermal runaway if the batteries are not maintained at appropriate operating parameters as a result of abnormal conditions and if not evaluated for ability to prevent propagation due to latent defects. Also there might be fire hazards due to short-circuiting abnormal conditions. 2. *Chemical hazards*: The potential exists for exposure of water-reactive lithium metal is minimal due to the small amount of lithium metal utilized in a cell. Water application would still the method of extinguishment. 3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. 4. *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. 5. *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts such as fans where guards might be missing.
Statement (technical reason for FR)	Recommend from task group 8 provides the updates needed to various descriptions on batteries.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

New B.5.8	235	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	B.5.8 Nickel Hydrogen Rechargeable nickel hydrogen batteries under charge conditions, the Nickel Hydroxide becomes Nickel Oxide hydroxide and hydrogen. During discharge the hydrogen is recombined with the Nickel Oxide hydroxide to give Nickel Hydroxide. The amount of hydrogen generated is a fixed amount that is a function of the amount of Nickel hydroxide. Hazard considerations for Nickel Hydrogen batteries under normal operating conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) Physical hazards: Not applicable. Hazard considerations for nickel hydrogen under emergency/abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: None indicated (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. (5) Physical hazards: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts such as fans where guards might be missing.		
First Revision Text (FR)	B.5.8 Nickel Hydrogen Rechargeable nickel hydrogen batteries under charge conditions, the Nickel Hydroxide becomes Nickel Oxide hydroxide and hydrogen. During discharge the hydrogen is recombined with the Nickel Oxide hydroxide to give Nickel Hydroxide. The amount of hydrogen generated is a fixed amount that is a function of the amount of Nickel hydroxide. Hazard considerations for Nickel Hydrogen batteries under normal operating conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement.		

	(5) Physical hazards: Not applicable. Hazard considerations for nickel hydrogen under emergency or abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: None indicated (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. Physical hazards: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts such as fans where guards might be missing.
Statement (technical reason for FR)	This proposal was submitted by the task group and provides the combination of annex text similar to other chemistries.
Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>New B.5.8</td><td>236</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">B.5.8 Zinc-Manganese Battery systems

Rechargeable Zn-MnO 2 batteries are composed of a zinc (Zn) anode, a manganese dioxide (MnO 2) cathode, and concentrated potassium hydroxide (KOH) solution as the electrolyte. The rechargeability of the battery is made possible by limiting the depth of discharge (DOD) of both the Zn anode and the MnO 2 cathode, and by controlling the discharge end voltage to avoid undesirable side reactions of the MnO 2 reduction. During discharge, the Zn anode follows a dissolution-precipitation process to give electrons and the MnO 2 cathode typically undergoes a proton intercalation process to close the loop.

Hazard considerations for Zinc-Manganese batteries under normal operating conditions are as follows:

(1) Fire hazards: Thermal runaway not noted during testing
(2) Chemical hazards: Not applicable.
(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.</td></tr>
</table>

	(4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) Physical hazards: Not applicable. Hazard considerations for Zinc-Manganese batteries under emergency/abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. (5) Physical hazards: Contact with internal components may cause irritation or burns. Potassium hydroxide (KOH) electrolyte is irritating to eyes, respiratory system, and skin.
First Revision Text (FR)	B.5.8 Zinc-Manganese Battery systems Rechargeable Zn-MnO2 batteries are composed of a zinc (Zn) anode, a manganese dioxide (MnO2) cathode, and concentrated potassium hydroxide (KOH) solution as the electrolyte. The rechargeability of the battery is made possible by limiting the depth of discharge (DOD) of both the Zn anode and the MnO 2 cathode, and by controlling the discharge end voltage to avoid undesirable side reactions of the MnO2 reduction. During discharge, the Zn anode follows a dissolution-precipitation process to give electrons and the MnO 2 cathode typically undergoes a proton intercalation process to close the loop. Hazard considerations for Zinc-Manganese batteries under normal operating conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) Physical hazards: Not applicable. Hazard considerations for Zinc-Manganese batteries under emergency/abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken.

	(5) Physical hazards: Contact with internal components may cause irritation or burns. Potassium hydroxide (KOH) electrolyte is irritating to eyes, respiratory system, and skin.
Statement (technical reason for FR)	This proposal was submitted by the task group and provides the combination of annex text similar to other chemistries.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New B.5.8	237	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	B.5.8 Zinc-Bromide Zinc-Bromide, non flow batteries Hazard considerations for Zinc-Bromide batteries under normal operating conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) Physical hazards: Not applicable. Hazard considerations for Zinc-Bromide batteries under emergency/abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. (5) Physical hazards: Contact with internal components may cause irritation or burns.		
First Revision Text (FR)	B.5.8 Zinc-Bromide Zinc-Bromide, non flow batteries Hazard considerations for Zinc-Bromide batteries under normal operating conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: Not applicable.		

	(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement. (5) Physical hazards: Not applicable. Hazard considerations for Zinc-Bromide batteries under emergency/abnormal conditions are as follows: (1) Fire hazards: Thermal runaway not noted during testing (2) Chemical hazards: (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken. (5) Physical hazards: Contact with internal components may cause irritation or burns.
Statement (technical reason for FR)	This proposal was submitted by the task group and provides the combination of annex text similar to other chemistries. The task group is also looking for information through the code development process to further clarify the new technologies.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New B.5.8	230	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	B.5.8 Metal Air Batteries - General Description Metal-air batteries have a metal anode (negative electrode) and an air “breathing” cathode (positive electrode) with an aqueous alkaline electrolyte. The combination of a metal anode with an air cathode provides an inexhaustible cathode reactant and the potential for high energy density. The capacity limit is determined by the amp-hour capacity of the anode and the means used to address reaction products. Metal air batteries are available in primary (non-rechargeable), reserve, and secondary (rechargeable) designs. The secondary designs can be either electrically rechargeable or mechanically rechargeable (replacing the discharged metal electrode) configurations. Electrical recharging of metal-air batteries requires either a third electrode (to sustain oxygen evolution on charge) or a bi-functional electrode (a single electrode capable of both oxygen reduction and evolution). This section of Annex B covers the electrical		

	recharging designs. There are multiple technologies under the electrically rechargeable metal air battery category including iron-air batteries, zinc-air batteries, and magnesium-air batteries. B.5.8.1 Iron-Air Batteries. Hazard considerations for iron-air batteries under normal operating conditions are as follows: 1. Fire hazards: There is the potential for concentrations of hydrogen from iron-air batteries if the area where the batteries are located is not properly ventilated. ~~However, this should be taken care of if the installation complies with the codes.~~ 2. Chemical hazards: These batteries have caustic electrolyte that is contained within the system during normal operation. Exposure risks may occur when handling electrolyte as a part of commissioning, decommissioning, and maintenance. Workers handling electrolyte need to use proper PPE. 3. Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. 4. Stranded or stored energy hazards: Not applicable. 5. Physical hazards: Not applicable. Hazard considerations for iron-air batteries under emergency/abnormal conditions are as follows: 1. Fire hazards: These systems have aqueous electrolytes, so the potential of hydrogen concentration buildup exists if the area where the batteries are located is not properly ventilated. 2. Chemical hazards: There is the potential for contact with caustic electrolyte during abnormal conditions should electrolytes leak. First responders, in emergency situations, need to be aware of potential caustic electrolyte spills that can occur and use appropriate caution around these batteries. 3. Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. 4. Stranded or stored energy hazards: Not applicable. 5. Physical hazards: The potential exists for overheating due to severe electrolyte loss from leaking. Exposure to moving parts such as fans where guards may be missing.
First Revision Text (FR)	B.5.8 Metal Air Batteries - General Description Metal-air batteries have a metal anode (negative electrode) and an air “breathing” cathode (positive electrode) with an aqueous alkaline electrolyte. The combination of a metal anode with an air cathode provides an inexhaustible cathode reactant and the potential for high energy density. The capacity limit is determined by the amp-hour capacity of the anode and the means used to address reaction products. Metal air batteries are available in primary (non-rechargeable), reserve, and secondary (rechargeable) designs. The secondary designs can be either electrically rechargeable or mechanically rechargeable (replacing the discharged metal electrode) configurations. Electrical recharging of metal-air batteries requires either a third electrode (to sustain oxygen evolution on charge) or a bi-functional electrode (a single electrode capable of both oxygen reduction and evolution). This section of Annex B covers the electrical recharging designs. There are multiple technologies under the electrically rechargeable metal air battery category including iron-air batteries, zinc-air batteries, and magnesium-air batteries. B.5.8.1 Iron-Air Batteries. Hazard considerations for iron-air batteries under normal operating conditions are as follows:

	1. Fire hazards: There is the potential for concentrations of hydrogen from iron-air batteries if the area where the batteries are located is not properly ventilated. 2. Chemical hazards: These batteries have caustic electrolyte that is contained within the system during normal operation. Exposure risks may occur when handling electrolyte as a part of commissioning, decommissioning, and maintenance. Workers handling electrolyte need to use proper PPE. 3. Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. 4. Stranded or stored energy hazards: Not applicable. 5. Physical hazards: Not applicable. Hazard considerations for iron-air batteries under emergency/abnormal conditions are as follows: 1. Fire hazards: These systems have aqueous electrolytes, so the potential of hydrogen concentration buildup exists if the area where the batteries are located is not properly ventilated. 2. Chemical hazards: There is the potential for contact with caustic electrolyte during abnormal conditions should electrolytes leak. First responders, in emergency situations, need to be aware of potential caustic electrolyte spills that can occur and use appropriate caution around these batteries. 3. Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. 4. Stranded or stored energy hazards: Not applicable. 5. Physical hazards: The potential exists for overheating due to severe electrolyte loss from leaking. Exposure to moving parts such as fans where guards may be missing.
Statement (technical reason for FR)	Create first revision with modification This revision provides the combination of annex text similar to other chemistries. The technical committee is looking for information through the code development process for the Second Draft to further clarify the new technologies.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New B.6.2	239	None	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	B.6.2 Hybrid Super capacitors Hazard considerations for Hybrid Super capacitors under normal operating conditions are as follows: (1) Fire hazards: (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance if they are at hazardous voltage and energy levels. Technicians should follow accepted maintenance and installation procedures when working on these capacitors. (4) Stranded or stored energy hazards: Although not as energy dense as batteries, there is the potential for some level of stranded energy in these devices. Care should be taken to discharge them prior to handling or disposal. Technicians should follow accepted maintenance and installation procedures when working on these capacitors. (5) Physical hazards: Not applicable. Hazard considerations for Hybrid Super capacitors under emergency/abnormal conditions are as follows: (1) Fire hazards: (2) Chemical hazards: (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: Although not as energy dense as batteries, there is the potential for some level of stranded energy in these devices if they are exposed to abnormal conditions. Damaged capacitors might contain stored energy that can be a hazard during disposal if care is not taken. Technicians should follow accepted procedures when working on these capacitors where these capacitors are subjected to abnormal conditions. (5) Physical hazards: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts such as fans where guards might be missing.
First Revision Text (FR)	B.6.2 Hybrid Super capacitors Hazard considerations for Hybrid Super capacitors under normal operating conditions are as follows: (1) Fire hazards: (2) Chemical hazards: Not applicable. (3) Electrical hazards: There are electrical hazards associated with routine maintenance if they are at hazardous voltage and energy levels. Technicians should follow accepted maintenance and installation procedures when working on these capacitors. (4) Stranded or stored energy hazards: Although not as energy dense as batteries, there is the potential for some level of stranded energy in these devices. Care should be taken to discharge them prior to handling or disposal. Technicians should follow accepted maintenance and installation procedures when working on these capacitors. (5) Physical hazards: Not applicable. Hazard considerations for Hybrid Super capacitors under emergency/abnormal conditions are as follows: (1) Fire hazards: (2) Chemical hazards:

	(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. (4) Stranded or stored energy hazards: Although not as energy dense as batteries, there is the potential for some level of stranded energy in these devices if they are exposed to abnormal conditions. Damaged capacitors might contain stored energy that can be a hazard during disposal if care is not taken. Technicians should follow accepted procedures when working on these capacitors where these capacitors are subjected to abnormal conditions. (5) Physical hazards: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts such as fans where guards might be missing.
Statement (technical reason for FR)	The task group felt this was a good start to begin the dialogue on the possible hazards and makeup of the technology. As additional testing occurs through the code development process additional information may be added through the process
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	261	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	Fire Command Center The principal attended or unattended room or area where the status of the detection, alarm communications, control systems, and other emergency systems is displayed and from which the system(s) can be manually controlled. (SIG-ECS) NFPA 72.[72:3.3.119].		
First Revision Text (FR)	Fire Command Center. The principal attended or unattended room or area where the status of the detection, alarm communications, control systems, and other emergency systems is displayed and from which the system(s) can be manually controlled. [72, 2022]		
Statement (technical reason for FR)	The extracted definition from NFPA 72 clarifies the location of the aggregated fire alarm signals, often referred to as a first responder station.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 4.7.1	289	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	4.7.1 Mixing of ESS Technologies. Where adverse interaction between two or more ESS technologies is possible, each shall be installed in a separate fire area.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some	This is currently addressed under Section 4.4.1 (2) in which an HMA is required and covers potentially adverse interactions of different ESS technologies.		

changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.8.1	259 (Cleaned- up version provided based on PI comment), 275	210, 7, 11, 317, 274, 275, 276, 287, 281	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	4.8 Smoke and Fire Detection. 4.8.2 Annunciation. 4.8.2.1 All required annunciation means shall be located as required by the authority having jurisdiction to facilitate an efficient response to the situation. [72:10.18.3.2] 4.8.2.2* Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ. A.4.8.2.2 As part of the smoke detection system's local annunciation, providing a fire alarm annunciation panel for emergency responders in an approved location where it can annunciate the ESS(s) being monitored should be considered. The location and information provided should be covered by the emergency operations plan required by 4.3.2.1 and evaluated as part of the HMA.		
First Revision Text (FR)	4.8.2.2* Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or other location approved by the AHJ.		
Statement (technical reason for FR)	This revision ensures that "other" approved locations are permitted as various sites may not have a formal fire command center or may have reporting to multiple locations.		
Response (technical reason for not making some changes or for resolving)			
4.8.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	7, 210		☒ Create First Revision ☐ Resolve
Proposed Text (PI)	4.8.1		

<table>
<tr><td></td><td colspan="3">Where required elsewhere in this standard, areas containing ESS systems shall be provided with a smoke detection, thermal image fire detection or radiant energy–sensing system in accordance with NFPA 72, unless modified by the requirements in Chapters 9 through 13.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.8.1*

Where required elsewhere in this standard, areas containing ESS systems shall be provided with a smoke detection, thermal image fire detection or radiant energy–sensing system in accordance with NFPA 72, unless modified by the requirements in Chapters 9 through 13.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">NFPA 72 2025 edition First Draft incorporated a new definition and requirements for "thermal image fire detectors." While thermal image detectors are technically radiant energy sensing detectors, NFPA 72 has previously limited radiant energy detectors to non-imaging flame or spark detectors (UV-IR, triple IR). The term radiant energy detectors is used within NFPA 855, thermal imaging is the appropriate term and technology for detecting overheating energy storage systems at an early stage. There is currently a new UL STP working on a new standard for video and thermal imaging fire detectors (UL/ULC 2684) and this is scheduled to be completed prior to the next edition of NFPA 855.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">A.4.8.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>11, 317 (same revision)</td><td></td><td>☒ Create First Revision

☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.8.1

Very early warning smoke detection systems can provide an earlier indication of a potential fire with an ESS. Smoke detectors listed to UL 268 7th edition and later are optimized for general commercial applications and are designed to comply with the new cooking nuisance smoke test (Normal Application Smoke Detection). Smoke detectors designated for Special Applications in UL 268 7th edition are designed to be used in applications that require higher sensitivity and that are less likely to be exposed to cooking nuisances. In addition, NFPA 72 permits aspirated smoke detector transport time of up to 120 seconds, consideration should be given to keeping the transport time below 90 seconds for earlier warning. In addition to detectors on the ceiling, consider placing smoke detectors or air sampling ports in the path of airflow within the ESS including within electrical cabinets. Detectors outside of the return air envelope are likely to have a delayed response since the fire will have to grow to such a size that it can overcome the forces of the mechanically generated airflow.

For lithium-ion ESS, a smoke detection system can be supplemented by a listed or approved off-gas detection system. Off-gas detection can increase the effectiveness of the smoke detection system for providing early response of an off-normal condition.

Gas detection technology can also provide additional information on conditions inside the ESS enclosure.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">A.4.8.1

Very early warning smoke detection systems can provide an earlier indication of a potential fire with an ESS. Smoke detectors listed to UL 268 7th edition and later are optimized for general commercial applications and are designed to comply with the new cooking nuisance smoke test (normal application smoke detection). Smoke detectors designated for special applications in UL 268 7th edition are designed to be used in applications that require higher sensitivity and that are</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">less likely to be exposed to cooking nuisances. In addition, NFPA 72 permits aspirated smoke detector transport time of up to 120 seconds, consideration should be given to keeping the transport time below 90 seconds for earlier warning. In addition to detectors on the ceiling, consider placing smoke detectors or air sampling ports in the path of airflow within the ESS including within electrical cabinets. Detectors outside of the return air envelope are likely to have a delayed response since the fire will have to grow to such a size that it can overcome the forces of the mechanically generated airflow.
~~For lithium-ion ESS, a smoke detection system can be supplemented by a listed or approved off-gas detection system. Off-gas detection can increase the effectiveness of the smoke detection system for providing early response of an off-normal condition.~~
~~Gas detection technology can also provide additional information on conditions inside the ESS enclosure.~~</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">The appendix language is revised to account for the updates to UL 268</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">4.8.1.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>273</td><td></td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.1.1 *
Normally unoccupied, remote standalone telecommunications structures with a gross floor area of less than 1500 ft 2 (139 m 2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1.
A. 9.6.1.1
Paragraph 4.8.1.1 aligns with 90.2(B)(4) of NFPA 70.
This requirement is intended to address small, normally unoccupied structures in remote locations, such as repeater stations, which are not adjacent to other important buildings or structures. It is not intended to apply to structures in an urban or suburban setting. The AHJ determines which structures are considered remote. The hardship of installing and maintaining smoke detection in these small, remote structures, along with heating and cooling to maintain the smoke detectors within listing specifications, is a reason for this exclusion.
See NFPA 76 for more information on fire detection for telecommunications structures.</td></tr>
</table>

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">~~4.8~~ 9.6.1.1 *
Normally unoccupied, remote standalone telecommunications structures with a gross floor area of less than 1500 ft 2 (139 m 2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1.
A. ~~4.8~~ 9.6.1.1
Paragraph ~~4.8~~9.6.1.1 aligns with 90.2(B)(4) of NFPA 70.
This requirement is intended to address small, normally unoccupied structures in remote locations, such as repeater stations, which are not adjacent to other important buildings or structures. It is not intended to apply to structures in an urban or suburban setting. The AHJ determines which structures are considered remote. The hardship of installing and maintaining smoke detection in these small, remote structures, along with heating and cooling to maintain the smoke detectors within listing specifications, is a reason for this exclusion.
See NFPA 76 for more information on fire detection for telecommunications structures.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">This revision is consistent with realignment of Chapter 4 to Chapters 9-13</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">4.8.1.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>274</td><td>259</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.1.2*
Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use the process control system to monitor the smoke detectors required in 4.8.1.
A. 9.6.1.2
Paragraph 4.8.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70.</td></tr>
</table>

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">~~4.8~~9.6.1.2*
Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use the process control system to monitor the smoke detectors required in 4.8.1.
A.~~4.8~~ 9.6.1.2
Paragraph ~~4.8~~9.6.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">This revision is consistent with realignment of Chapter 4 to Chapters 9-13.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">A.4.8.2.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>287</td><td>259</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.8.2.2
- The intent of this section is to ensure that all the signals are aggregated at a single location that can be readily and safely observed throughout the duration of the event. This is defined as the Fire Command Center (FCC) but also may be referred to as a “First Responder Station”, though this terminology is not preferred as first responders may refer to other emergency personnel other than the fire department (police, EMS, etc.) which may not need access to the FCC. All information that the fire service might need to rely on (smoke, gas, or heat detection, fan operation, fan control, etc.) should all be accessible and when necessary operable from the FCC.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">A.4.8.2.2
This section is to ensure that all the signals are aggregated at a single location that can be readily and safely observed throughout the duration of the event. This is defined as the Fire Command Center (FCC) but also may be referred to as a “first responder station”, though this terminology is not preferred as first responders may refer to other emergency personnel other than the fire department (police, EMS, etc.) which may not need access to the FCC. All information that the fire service might need to rely on (smoke, gas, or heat detection, fan operation, fan control, etc.) should all be accessible and when necessary operable from the FCC.
~~As part of the smoke detection system’s local annunciation, providing a fire alarm annunciation panel for emergency responders in an approved location where it~~</td></tr>
</table>

	~~can annunciate the ESS(s) being monitored should be considered. The location and information provided should be covered by the emergency operations plan required by~~ **~~4.3.2.1~~** ~~and evaluated as part of the HMA.~~		
Statement (technical reason for FR)			
4.8.3	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	276	259	☐☒ Create First Revision ☐ Resolve
Proposed Text (PI)	~~4.8.3~~ 9.6.1.5* Smoke and fire detection systems protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply in accordance with *NFPA 72* capable of 24 hours in standby and 2 hours in alarm. A.~~4.8.3~~ 9.6.1.5 The HMA or deflagration evaluation study in conjunction with UL 9540A or fire and explosion test data will be used to support the requirement for additional power supply backup above and beyond NFPA 72 requirements. This requirement applies to lithium-ion technologies because testing and actual events have shown that events can be several hours in duration. The additional backup will allow first responders to monitor situational conditions for longer periods of time.		
First Revision Text (FR)	~~4.8.3~~ 9.6.1.5* Smoke and fire detection systems protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply in accordance with *NFPA 72* capable of 24 hours in standby and 2 hours in alarm. A.~~4.8.3~~ 9.6.1.5 The HMA or deflagration evaluation study in conjunction with UL 9540A or fire and explosion test data will be used to support the requirement for additional power supply backup above and beyond NFPA 72 requirements. This requirement applies to lithium-ion technologies because testing and actual events have shown that events can be several hours in duration. The additional backup will allow first responders to monitor situational conditions for longer periods of time.		
Statement (technical reason for FR)	This revision is consistent with realignment of Chapter 4 to Chapters 9-13.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.9.1.1, 4.9.1.2, 4.9.1.3	119		☒ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	~~4.9.1.1 * Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 shall not be required to have a fire suppression system installed.~~ ~~A.4.9.1.1~~ ~~Paragraph 4.9.1.1 aligns with 90.2(B)(4) of NFPA 70.~~ ~~4.9.1.2 Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application utilized for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed.~~ ~~4.9.1.3 * Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire suppression system installed.~~ ~~A.4.9.1.3~~ ~~This is in line with the scope of 90.2(D)(5) of NFPA 70 and applies to lead-acid or nickel-cadmium batteries.~~		
Statement (technical reason for FR)	These exemptions are battery specific and are repeated in Chapter 9 Section 9.6.2.2. They can be removed from Chapter 4.		
Response (technical reason for not making some changes or for resolving)			
4.9.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	361, 362, 363		☐ Create First Revision ☒ Resolve

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.9.1.1*
Lead-acid, nickel-cadmium, and zinc-manganese battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 shall not be required to have a fire suppression system installed.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3"></td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">No data provided demonstrating equivalency to lead acid or nickel cadmium.</td></tr>
<tr><td rowspan="2">~~4.9.1.2~~</td><td>~~All PIs used for FR or Resolve~~</td><td>~~Other PIs that propose revisions for this section~~</td><td>~~MOTION~~</td></tr>
<tr><td>~~362, 361, 363~~</td><td></td><td>~~☐ Create First Revision~~
~~☒ Resolve~~</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.9.1.2
Lead-acid and zinc-manganese battery systems in uninterruptable power supplies listed and labeled in accordance with the application utilized for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3"></td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">No data provided demonstrating equivalency to lead acid or nickel cadmium.</td></tr>
<tr><td rowspan="2">~~4.9.1.3~~</td><td>~~All PIs used for FR or Resolve~~</td><td>~~Other PIs that propose revisions for this section~~</td><td>~~MOTION~~</td></tr>
<tr><td>~~363, 361, 362~~</td><td></td><td>~~☐ Create First Revision~~
~~☒ Resolve~~</td></tr>
</table>

Proposed Text (PI)	4.9.1.3* Lead-acid, nickel-cadmium, and zinc-manganese battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire suppression system installed.
First Revision Text (FR)	
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	No data provided demonstrating equivalency to lead acid or nickel cadmium.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.9.3	220	326	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	4.9.3 Alternate Automatic Fire Control, Suppression and Thermal Runaway Mitigation Systems. 4.9.3.1* Other automatic fire control,-suppression, and thermal runaway mitigation systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5. 4.9.3.2* The automatic fire control,-suppression, and thermal runaway mitigation systems shall comply with the following standards, or their equivalent, as appropriate: (1) NFPA 12 (2) NFPA 15 (3) NFPA 750 (4) NFPA 770 (5) NFPA 2001 (6) NFPA 2010 (7) UL 9540		
First Revision Text (FR)			

<table>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3">Insufficient information provided to demonstrate that a thermal runaway mitigation system is similar to control/suppression and should be included here. Insufficient information provided that UL9540 is sufficient for acceptability of the system. This section is for the protection of the room or space, thus if it is not a fire protection system then it does not belong in this list/section.</td></tr>
<tr><td>4.9.3.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>326</td><td>~~220~~</td><td>☐ Create First Revision
☒ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.9.3.2*
The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:
(1) NFPA 12
(2) NFPA 15
(3) NFPA 18A
(4) NFPA 750
(5) NFPA 770
(6) NFPA 2001
(7) NFPA 2010</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3">Insufficient information provided that NFPA 18A is sufficient for acceptability of the system.</td></tr>
<tr><td>Section</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>4.9.3</td><td></td><td></td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.9.3.2*
The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:
~~(1) NFPA 12~~
(1~~2~~) NFPA 15
(2~~4~~) NFPA 750
~~(5) NFPA 770~~</td></tr>
</table>

	~~(6) NFPA 2001~~ ~~(7) NFPA 2010~~ A.4.9.3.2 ~~Gaseous Agents. Gaseous agent fire suppression systems can be used to protect ESS fires in either of the following two ways:~~ ~~(1)Total flooding systems are used where there is a permanent enclosure around the fire hazard that is adequate to enable the design concentration to be built up and maintained for the time required to ensure the complete and permanent extinguishment of a fire for the specific combustible materials involved. For total flooding systems, potential leakage sources should be included in the gaseous agent design quantities, which should include leakage through ventilation dampers. Usually, ventilation dampers are either gravity actuated (i.e., close when the ventilation fans automatically shut down upon gaseous agent discharge) or pressure actuated (i.e., close by means of counterweight and a pressure-operated latch that is activated by the gaseous agent). Leakage from the interface between the enclosure walls and the foundation should also be taken into consideration. For ESS enclosures where the normal temperature of the enclosure exceeds 200°F (93°C) or is below 0°F (−18°C), gaseous agent levels should be adjusted as required by the appropriate NFPA standard or the manufacturer's instruction manual.~~ ~~(2)Local application systems are used for the extinguishment of surface fires of combustible gases, liquids, or solids where the fire hazard is not enclosed or where the enclosure does not conform to the requirements for a total flooding system. For local application systems, it is imperative that the entire fire hazard be protected. The hazard area should include all areas that are subject to spillage, leakage, splashing, condensation, and so forth and are of combustible materials that might extend a fire outside the protected area or lead a fire into the protected area. This type of hazard could necessitate dikes, drains, or trenches to contain any combustible material leakage. When multiple ESS equipment fire hazards are in an area such that they are interposing, provisions should be made to ensure that the hazards can be protected simultaneously, which could involve subdividing the hazards into sections and providing independent protection to each section.~~ ~~See G.6.1.4 for more information on the use of gaseous/clean agent fire suppression with LIB-based ESS.~~ Water Mist. Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific ESS installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer's system through fire and explosion testing in accordance with 9.1.5 to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750. See G.6.1.3 for more information on the use of water mist systems with LIB-based ESS.
Statement (technical reason for FR)	Other fire control and suppression have not been shown to effectively control LIB fires except NFPA 15 and NFPA 750 systems.
Response (technical reason for not making some	

changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.1	255, 217 (same revision for 9.6.1), 118 (same revision for 9.6.1.1 and 9.6.1.2), 219 (same revision for 9.6.1.2 and A.9.6.1.2), 222 (same revision for 9.6.1.3), 223 (same revision for 9.6.1.4 and A.9.6.1.4), 271 (same revision for 9.6.1.5 and A.9.6.1.5), 272 (same revision for 9.6.1.6), 8		☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.1 Smoke and Fire Detection. Areas containing ESS systems located within buildings or structures shall be provided with a smoke detection or radiant energy–sensing system in accordance with ~~Section 4.8~~ NFPA 72, unless modified by this chapter. 9.6.1.1 * Normally unoccupied, remote standalone telecommunications structures with a gross floor area of less than 1500 ft2 (139 m2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1. A.9.6.1.1 Paragraph 9.6.1.1 aligns with 90.2(B)(4) of NFPA 70. This requirement is intended to address small, normally unoccupied structures in remote locations, such as repeater stations, which are not adjacent to other important buildings or structures. It is not intended to apply to structures in an urban or suburban setting. The AHJ determines which structures are considered remote. The hardship of installing and maintaining smoke detection in these small, remote structures, along with heating and cooling to maintain the smoke detectors within listing specifications, is a reason for this exclusion. See NFPA 76 for more information on fire detection for telecommunications structures. 9.6.1.2 * Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use the process control system to monitor the smoke detectors required in 4.8.1. A.9.6.1.2 Paragraph 4.8.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70.		

	9.6.1.3 All required annunciation means shall be located as required by the authority having jurisdiction to facilitate an efficient response to the situation. [72:10.18.3.2] 9.6.1.4 * Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ. A.9.6.1.4 As part of the smoke detection system's local annunciation, providing a fire alarm annunciation panel for emergency responders in an approved location where it can annunciate the ESS(s) being monitored should be considered. The location and information provided should be covered by the emergency operations plan required by 4.3.2.1 and evaluated as part of the HMA. 9.6.1.5 * Smoke and fire detection systems protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply in accordance with NFPA 72 capable of 24 hours in standby and 2 hours in alarm. A.9.6.1.5 The HMA or deflagration evaluation study in conjunction with UL 9540A or fire and explosion test data will be used to support the requirement for additional power supply backup above and beyond NFPA 72 requirements. This requirement applies to lithium-ion technologies because testing and actual events have shown that events can be several hours in duration. The additional backup will allow first responders to monitor situational conditions for longer periods of time. 9.6.1.6 Alarm signals from detection systems shall be transmitted to a supervising station in accordance with NFPA 72.
First Revision Text (FR)	9.6.1 Smoke and Fire Detection. ESS systems shall be provided with a smoke detection, thermal image fire detection, or radiant energy–sensing system in accordance with NFPA 72, unless modified by this chapter. ~~4.8~~ 9.6.1.1 * Normally unoccupied, remote standalone telecommunications structures with a gross floor area of less than 1500 ft2 (139 m2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1. A. ~~4.8~~ 9.6.1.1 ~~Paragraph~~ Section ~~4.8~~9.6.1.1 aligns with 90.2(B)(4) of NFPA 70. This requirement is intended to address small, normally unoccupied structures in remote locations, such as repeater stations, which are not adjacent to other important buildings or structures. It is not intended to apply to structures in an urban or suburban setting. The AHJ determines which structures are considered remote. The hardship of installing and maintaining

	smoke detection in these small, remote structures, along with heating and cooling to maintain the smoke detectors within listing specifications, is a reason for this exclusion. See NFPA 76 for more information on fire detection for telecommunications structures. ~~4.8~~9.6.1.2* Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use the process control system to monitor the smoke detectors required in 4.8.1. A.9.6.1.2 ~~Paragraph~~ Section ~~4.8~~9.6.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70. 9.6.1.3 All required annunciation means shall be located as required by the authority having jurisdiction to facilitate an efficient response to the situation. [72:10.18.3.2] 9.6.1.4 * Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ. A.9.6.1.4 As part of the smoke detection system's local annunciation, providing a fire alarm annunciation panel for emergency responders in an approved location where it can annunciate the ESS(s) being monitored should be considered. The location and information provided should be covered by the emergency operations plan required by 4.3.2.1 and evaluated as part of the HMA. ~~4.8.3~~ 9.6.1.5* Smoke and fire detection systems protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply in accordance with NFPA 72 capable of 24 hours in standby and 2 hours in alarm. A.~~4.8.3~~ 9.6.1.5 The HMA or deflagration evaluation study in conjunction with UL 9540A or fire and explosion test data will be used to support the requirement for additional power supply backup above and beyond NFPA 72 requirements. This requirement applies to lithium-ion technologies because testing and actual events have shown that events can be several hours in duration. The additional backup will allow first responders to monitor situational conditions for longer periods of time. 9.6.1.6 Alarm signals from detection systems shall be transmitted to a supervising station in accordance with NFPA 72.

Statement (technical reason for FR)	This revision cleans up the smoke and fire detection requirements; correlates the requirements with NFPA 72 and NFPA 70. It relocates technology specific requirements and clarifies that walk-in units are treated as indoor installations.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.2.1	300	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.2.1 Rooms or areas within buildings and outdoor walk-in units containing ESS shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.		
First Revision Text (FR)	9.6.2.1 ~~Fire control and suppression for r~~Rooms or areas within buildings and outdoor walk-in units containing ESS shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.		
Statement (technical reason for FR)	This revision clarifies that internal protection of containerized ESS is only required when it is a walk-in unit. If the unit is non-walk-in but exceeds the maximum size (53') then it is treated as a building per chapter 9 and would require protection via that mechanism.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.6.2.2.4	147, 142, 162, 168	142, 168 (different wording)	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.2.2.4 Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.		
First Revision Text (FR)	9.6.2.2.4		

	Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.
Statement (technical reason for FR)	Lead-acid batteries and nickel-cadmium batteries tested and listed to UL 1973 have shown they are safe technologies, which do not go into thermal runaway, and do not catch fire. These technologies have electrolyte that is aqueous that will not burn and will hinder any ignition. The plastic material used for the cover and container per UL 1973 are self-extinguishing plastics rated per UL 94, V2 or higher, in most cases rated the highest at V0. This has been proven as well per UL 1973 environmental test, Section 41 External Fire Exposure for Projectile Hazards Test.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.6.5.5.3	299	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.2.4 For pre-engineered systems that are not compliant with NFPA 13, 15, or equivalent, the system piping and appurtenances shall be ASTM B31.2 compliant and shall be as such in the UL9540 listing in accordance with 4.6.1.		
First Revision Text (FR)	9.6.5.5.3 For fluid based supplemental engineered and pre-engineered thermal runaway protection systems, the system piping and appurtenances shall be compliant with all applicable parts of ASME B31. The effectiveness of the system shall be documented in accordance with REFER TO LARGE SCALE TESTING SECTION and shall be documented as such in the UL9540 listing in accordance with 4.6.1.		
Statement (technical reason for FR)	This makes it clear that systems are still required to meet a piping/appurtenances standard even if they don't comply with 13, 15, or equivalent. Currently many pre-engineered systems do not have a proper piping listing when seeking the 9540 listing and in some cases the systems are erroneously stated to meet the requirements of 13 or 15 and when they are reviewed prior to installation/commissioning there is a gap as the systems do not comply.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 9.6.3	303, 307, 311	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.3* Chemistries capable of thermal runaway based on 9.1.5, shall not include clean agent or aerosol suppression systems except as permitted per 9.6.x.1 or 9.6.x.2. A.9.6.3 Chemistries capable of thermal runaway and production of flammable gases present a conflicting mitigation challenge when clean agent or aerosol agents are deployed on BESS enclosures. The challenge of mitigating the deflagration risk with a deflagration prevention system are made ineffective by an agent that requires the sealing of the enclosure and may result in an increasing deflagration hazard via activation of the system. Therefore the priority must be reducing deflagration risk rather than suppression of a fire.		
First Revision Text (FR)	**9.6.3 Integrated and Commissioning of Active and Passive Fire Protection and Life Safety System Test** **9.6.3.1 Basic Testing.** Where installations involving two or more integrated fire protection or life safety systems are present, the systems shall be tested to verify the proper operation and function of such systems in accordance with 9.6.3.1.1 and 9.6.3.1.2. **9.6.3.1.1** When a fire protection or life safety system is tested, the response of integrated fire protection and life safety systems shall be verified. **9.6.3.1.2** After repair or replacement of equipment, required retesting of integrated systems shall be limited to verifying the response of fire protection or life safety functions initiated by repaired or replaced equipment. **9.6.3.2 NFPA 4 Testing.** **9.6.3.2.1** For new buildings, integrated testing in accordance with NFPA 4 shall be conducted prior to the issuance of a certificate of occupancy. **9.6.3.2.2** For existing buildings, integrated testing in accordance with NFPA 4 shall be conducted at intervals not exceeding 5 years unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4.		

	9.6.3.3 NFPA 3 Commissioning. The procedures, methods, and documentation for the commissioning of active and passive fire protection and life safety systems and their interconnections with other building systems shall be in accordance with NFPA 3
Statement (technical reason for FR)	Fire protection systems need to demonstrate that they are capable of addressing all the hazards in the protected space.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.3.1	329	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	9.6.3.1 Sites where ESS are installed shall be provided with a permanent source of water for fire protection in accordance with 4.9.4, unless modified by this chapter.		
First Revision Text (FR)	9.6.3.1 Sites where ESS are installed shall be provided with a permanent source of water for fire protection in accordance with 4.9.4, unless modified by this chapter.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This is already addressed in Chapter 9.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.4.1	249	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	9.6.4.1* Rooms or spaces, containing only ESS listed to UL 9540, or an AHJ approved equivalent process, and that are marked as meeting the cell-level performance criteria of UL 9540A, shall be		

	permitted to be separated from other areas of the building with a minimum 1-hour fire resistance rating constructed in accordance with local building codes. A.9.6.4.1 Because purpose build structures are usually built on site, UL 9540 manufacturing certification may not be feasible. In this condition a Limited Production Certification (LPC) may be appropriate. In certain case an AHJ may approve an ESS Field Evaluation if equivalence can be shown.
First Revision Text (FR)	.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	No other approval method exists and the proposed text is an unnecessary burden on the AHJ.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.1	159	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.3.1* General. For ESS installations ~~that exceed the maximum stored energy limits of Table 9.4.1~~, emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations and maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.		
First Revision Text (FR)	4.3.1* General. For ESS installations ~~that exceed the maximum stored energy limits of Table 9.4.1~~, emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations and maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.		
Statement (technical reason for FR)	The current edition had a very high threshold for when emergency planning and training is required. This revision reduces the threshold so that all ESS regulated by NFPA 855 have this crucial emergency planning and training.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.2	225	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.3.2 For ESS installations ~~that exceed the maximum stored energy limits of Table 9.4.1~~, an emergency operations plan and associated training shall be established, maintained, and conducted by ESS facility operations and maintenance personnel.		
First Revision Text (FR)	4.3.2 Facility Staff Planning and Training. For ESS installations ~~that exceed the maximum stored energy limits of Table 9.4.1~~, an emergency operations plan and associated training shall be established, maintained, and conducted by ESS facility operations and maintenance personnel.		

Statement (technical reason for FR)	The current edition had a very high threshold for when an emergency operations plan and associated training is required. This revision reduces the threshold so that all ESS regulated by NFPA 855 have this critical emergency operations plan and associated training.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.2.1.2	226	None	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	4.3.2.1.2 ~~For normally occupied facilities, the~~ The emergency operations plan shall be on site in an approved location or available digitally where approved by the AHJ.
First Revision Text (FR)	4.3.2.1.2 ~~For normally occupied facilities, t~~The emergency operations plan shall be on site in an approved location or available digitally where approved by the AHJ.
Statement (technical reason for FR)	The emergency operations plan is already required, this revision provides clarification that the plan needs to be provided to the first responders either on site or through a digital means in order to keep everyone on the same page and safe.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.2.1.4	60	216, 285	☐ Create First Revision ☒~~☐~~ Resolve

Proposed Text (PI)	4.3.2.1.4 The emergency operations plan shall include the following: (1) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries, and for safe start-up following cessation of emergency conditions (2) Procedures for inspection and testing of associated alarms, interlocks, and controls (3) *Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down

	equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required (4) *Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions (5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required (6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for ~~personnel~~ a qualified person to safely remove damaged ESS equipment from the facility (7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders (8) Procedures and schedules for conducting drills of these procedures		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	The term “qualified person”, which is defined in 3.3.20, deals with persons that have knowledge of the construction and operation of a BESS. The person required in this section is a person qualified to remove damaged batteries which requires special knowledge and training.		
4.3.2.1.4	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	285	20, 216	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.3.2.1.4 The emergency operations plan shall include the following: (1) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries~~, and for safe start-up following cessation of emergency conditions~~ (2) Procedures for inspection and testing of associated alarms, interlocks, and controls (3) *Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required (4) *Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions (5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required		

<table>
<tr><td colspan="1"></td><td colspan="3">(6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility
(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders
(8) Procedures and schedules for conducting drills of these procedures</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.3.2.1.4
The emergency operations plan shall include the following:
1. Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries~~, and for safe start-up following cessation of emergency conditions~~
2. Procedures for inspection and testing of associated alarms, interlocks, and controls
3. *Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required
4. *Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions
5. Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required
6. Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility
7. Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders
8. Procedures and schedules for conducting drills of these procedures</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">It is not necessary for the Emergency Operations Plan to address the safe re-start up procedures. Start up following an emergency needs to be in accordance with the commissioning plan and not the EOP.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">4.3.2.1.4</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>216</td><td>60, 285</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.3.2.1.4
The emergency operations plan shall include the following:</td></tr>
</table>

	(1) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries, and for safe start-up following cessation of emergency conditions (2) Procedures for inspection and testing of associated alarms, interlocks, and controls (3) *Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required (4) *Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions (5) Response considerations that address safety concerns covering response, mitigation, and extinguishment, similar to those found in a safety data sheet (SDS)~~ that will address response safety concerns and extinguishment~~, even when an SDS is not required (6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility (7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders (8) Procedures and schedules for conducting drills of these procedures
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	This public input does not add any benefit to the standard compared to the current language. Under the Global Harmonization System all SDSs have the same sections, so the proposed subjects are already addressed.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.2.1.5	109	227	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.3.2.1.5 The emergency operations plan in 4.3.2.1 shall not be required for electric or communications utility facilities under the exclusive control of the ~~electric~~ utility located outdoors or in building spaces used exclusively for such installations.		
First Revision Text (FR)	See below for revised text.		

Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This proposed exemption is too broad. Buildings and enclosures, even outdoors, need emergency operations plan. The burden of creating this plan and training is not that difficult and the benefit to the ESS facility operations and maintenance personnel, first responders and the community easily outweighed the work necessary to create planning and training.		
4.3.2.1.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	227	109	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.3.2.1.5 ~~The emergency operations plan in 4.3.2.1 shall not be required for electric utility facilities under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations.~~		
First Revision Text (FR)	4.3.2.1.5 The emergency operations plan in 4.3.2.1 shall not be required for electric utility facilities under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations.		
Statement (technical reason for FR)	The current verbiage in the standard does not require a critical safety plan to be required for electric utilities under the exclusive control of the electrical utility located outdoors or in a building space used exclusively for such installations. An emergency operations plan needs to be required for all ESS installations, even those under control of the utilities. Having this plan allows are first responders to understand their role in mitigating the incident as well as providing support to the utility company personnel. Not having this plan, leaves are first responders in the dark as to what they should or should not be doing at these types of facilities which creates an unnecessary hazardous situation for our first responders.		
Response (technical reason for not making some changes or for resolving)	A task group has been formed to further address the emergency operations plan and the exclusions for larger battery ESS and standby power within substations.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 4.3.2.1.6	191	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	4.3.2.1.6 Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of		

	communications utilities used in stationary standby service and located outdoors or in building spaces used exclusively for such installations that comply with NFPA~~P~~ 76 shall not require emergency operations plan in 4.3.2.1.
First Revision Text (FR)	To create a FR, revise text above or paste final version here.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	NFPA 76 does have requirements for an emergency operations plan, the threshold when these are required is too high for this critical emergency operations plan and associated training. The burden of creating this plan and training is not that difficult and the benefit to the ESS facility operations and maintenance personnel, first responders and the community easily outweighed the work necessary to create planning and training.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.3.2.2.1	160, 286	286	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.3.2.2.1 Personnel responsible for the installation of the ESS shall be trained prior to the ESS arriving onsite, in the procedures included in the emergency operations plan in 4.3.2.1. Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained prior to the commissioning of the ESS, in the procedures included in the emergency operations plan in 4.3.2.1.		
First Revision Text (FR)	4.3.2.2.1 Personnel responsible for the installation of the ESS shall be trained prior to the ESS arriving onsite, in the procedures included in the emergency operations plan in 4.3.2.1. 4.3.2.2.2. Personnel responsible for the operation, maintenance, and repair ~~, servicing, and response~~ of the ESS shall be trained prior to the commissioning of the ESS, in the procedures included in the emergency operations plan in 4.3.2.1.		
Statement (technical reason for FR)	This revision clarifies when training is needed to occur for two different groups of facility personnel. Personnel that are part of the initial installation of the ESS need to be trained prior to the ESS arriving onsite so that they are prepared once the ESS arrives. Those personnel that are responsible for the operation, maintenance, repair, serving and response after the ESS is installed, must be trained prior to the ESS being commissioned. Splitting up when the training is required will benefit both groups so they receive relevant training and so they are prepared for any incidents during the phase of installation that falls within their scope of responsibility.		

Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>New 4.3.3</td><td>158</td><td>None</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.3.3 Emergency Response Plan

4.3.3.1

For ESS installations, an emergency response plan and associated training shall be established, maintained, and conducted so that ESS facility operations personnel and emergency responders can address foreseeable hazards associated with the on-site emergencies.

4.3.3.2 Emergency Response Plan Details

4.3.3.2.1
The emergency response plan shall be in accordance with Chapters 17 through 23 of NFPA 1660.

4.3.3.2.2
The emergency response plan shall, at a minimum, address the following:
1. Mitigation
2. Preparedness
3. Response
4. Recovery

4.3.3.3 Training

4.3.3.3.1

Personnel responsible for the installation of the ESS shall be trained in the procedures included in the emergency response plan ~~in 4.3.3~~ prior to the ESS arriving onsite.

4.3.3.3.2
Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the commissioning of the ESS.

4.3.3.4 Refresher Training

4.3.3.4.1</td></tr>
</table>

	Refresher training shall be conducted by ESS facility operations personnel at least annually. 4.3.3.4.2. Records of such training shall be retained in an approved manner. 4.3.3.5 Notification Emergency responders shall be notified of the training dates and locations.
First Revision Text (FR)	To create a FR, revise text above
Statement (technical reason for FR)	This new section requires an emergency response plan. The emergency response plan differs from the previously required emergency operations plan as this plan lays out a series of steps the facility will take during a critical event, such as a fire or active shooter threat, to ensure employees' safety and minimize the impact on critical operations. The plan also brings in certain requirements from NFPA 1660 on how to mitigate an event, how to prepare for a event, how to respond to an event and how to recover from an event in order to get back to normal operations. Some of these items will be a collaboration with the local first responders especially on the response topic. The rest of the new section uses similar language from previous sections regarding training and refresher training. The last part of the new section is notification. This is a requirement that the facility needs to contact the local emergency responders of the when and where for the required training. This doesn't necessarily mean that the emergency responder will participate in every training; its just a notification of the training. This new section brings in a new plan that was previously missing in the standard which is aimed at everyone working together if there is an incident at the facility.
Response (technical reason for not making some changes or for resolving)	The requirements for training and refresher training is burdensome. The requirements need to modified to address the hazards for differences in technologies.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
7.1.1 and 7.1.2	23, 93	93, 234	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	7.1.1 Electric Utilities Under NERC Jurisdiction. 7.1.1.1 Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements. 7.1.1.2 Electric utilities under NERC jurisdiction shall not be required to follow manufacturer’s instructions for lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ orderly shutdown of generating stations under the		

	exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations. 7.1.2 The operation and maintenance documentation shall include the following: (1) Procedures for the ~~safe~~ startup of the ESS system and associated equipment (2) Procedures for inspection and testing of associated alarms, interlocks, and controls (3) Procedures for maintenance and operation of the following, where applicable: (a) Energy storage management systems (ESMS) (b) Fire protection equipment and systems (c) Spill control and neutralization systems (d) Exhaust and ventilation equipment and systems (e) Gas detection systems (f) Other required safety equipment and systems (4) Response considerations similar to a safety data sheet (SDS) that address response safety concerns and extinguishment where an SDS is not required (5) *An instruction that equipment or system changes to the installation are required to be recorded by updating any engineering documentation
First Revision Text (FR)	7.1.1 Electric Utilities Under NERC Jurisdiction. 7.1.1.1 Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements. 7.1.1.2 Electric utilities under NERC jurisdiction shall not be required to follow manufacturer's instructions for lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations. 7.1.2 The operation and maintenance documentation shall include the following: 1. Procedures for the ~~safe~~ startup and shutdown of the ESS system and associated equipment 2. Procedures for inspection and testing of associated alarms, interlocks, and controls

<table>
<tr><td></td><td colspan="3">3. Procedures for maintenance and operation of the following, where applicable:
1. Energy storage management systems (ESMS)
2. Fire protection equipment and systems
3. Spill control and neutralization systems
4. Exhaust and ventilation equipment and systems
5. Gas detection systems
6. Other required safety equipment and systems
4. Response considerations similar to a safety data sheet (SDS) that address response safety concerns and extinguishment where an SDS is not required
5. *An instruction that equipment or system changes to the installation are required to be recorded by updating any engineering documentation</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The term “safe” in 7.1.1.2 and 7.1.2 brings no value to the standard.
The terms “and shut down” brings great value to the standard as the shutdown procedures are key to the safety of BESSs. The safety procedures should include shut down of the ESS. In the case of some technologies, shutting down of the ESS may be more involved than turning off the inverters.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">The term “safety” in safety equipment in (3)(f) and in safety concerns in (4) is widely used and recognized so there is no need to delete it.</td></tr>
<tr><td rowspan="2">7.1.2</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>234</td><td>23, 93</td><td>☐ Create First Revision
☒ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">7.1.2
The operation and maintenance documentation shall include the following:
(1) Procedures for the safe startup of the ESS system and associated equipment
(2) Procedures for inspection and testing of associated alarms, interlocks, and controls
(3) Procedures for maintenance and operation of the following, where applicable:
(a) Energy storage management systems (ESMS)
(b) Fire protection equipment and systems</td></tr>
</table>

	(c) Spill control and neutralization systems (d) Exhaust and ventilation equipment and systems (e) Gas detection systems (f) Other required safety equipment and systems (4) ~~Response considerations similar to a safety data sheet (SDS) that address response safety concerns and extinguishment where an SDS is not required~~Emergency response plan shall be prepared according to *4.3 Emergency Planning and Training* (5) *An instruction that equipment or system changes to the installation are required to be recorded by updating any engineering documentation ~~7.1.3 SDS for Hazardous Materials.~~ ~~7.1.3.1~~ ~~SDS for hazardous materials contained in the ESS shall be posted within sight of the disconnecting means of any ESS or at a location approved by the AHJ.~~ ~~7.1.3.2~~ ~~For ESS located outdoors, a means shall be provided to protect the SDS from the weather.~~
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Item (4) is important to the standard as it keeps the requirements for information necessary for response consideration even if an SDS is not onsite. Furthermore, there is no justification to remove the SDS requirement as its federally required and required by most fire codes.

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>New A.4.6.3.1</td><td>90</td><td>None</td><td>☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.6.3.1
Some flow batteries can be retrofitted with additional energy storage, discharge or recharge capacity without having to replace the entire battery. For example, additional energy storage could be added by replacing or adding more electrolyte tanks to an existing battery. The flow battery must remain in scope of the product listing in order to comply with 4.6.3.1</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.6.3.1
Retrofits of ESS shall be approved and comply with the following unless modified in other sections:
1. Battery systems and modules and capacitor systems and modules shall be listed in accordance with UL 1973 and installed in accordance with the manufacturer’s instructions.
2. ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer’s instructions.
3. The overall installation shall continue to comply with UL 9540 listing requirements, where applicable.
4. Retrofits shall be documented in the maintenance, testing, and events log required in 4.2.3.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
</table>

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>New 4.6.5.1</td><td>334</td><td>None</td><td>☐ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.6.5.1
Repurposed, remanufactured, and refurbished batteries shall also comply with 9.2.4.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">To create a FR, revise text above or paste final version here.</td></tr>
</table>

Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.4.4	215	214	☐ Create First Revision ☐ Resolve
Proposed Text (PI)	6.4.4* Listed ESS that has been modified in the field beyond the field-installed options that are part of the listing shall be investigated and found suitable by the organization that listed the equipment or by an approved certification organization.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)			
A.6.4.4	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	214	215	☐ Create First Revision ☐ Resolve
Proposed Text (PI)	A.6.4.4 When listed ESS is modified in the field, it can change its ability to comply with the requirements in the standard used to list the product. It is difficult or impossible for AHJs and service personnel to verify that the modified product complies with those requirements. Certification organizations have the expertise to evaluate product modifications and ~~have field evaluation programs to investigate the modified product and provide a field evaluation label~~ their impact on the product listing. It is not anticipated that ~~a field evaluation is needed~~ certification organizations need to evaluate modifications that are identified in the instruction manual provided with the listed equipment, such as swapping out or adding listed modules. It is also not anticipated that a ~~field evaluation is needed for~~ certification organization needs to evaluate like-for-like repairs that do not impair the overall safety of the product.		

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	6.4.4* Listed ESS that has been modified in the field beyond the field-installed options that are part of the listing shall be investigated and found suitable by the organization that listed the equipment. A.6.4.4 When listed ESS is modified in the field, it can change its ability to comply with the requirements in the standard used to list the product. It is difficult or impossible for AHJs and service personnel to verify that the modified product complies with those requirements. Certification organizations have the expertise to evaluate modifications and have field evaluation programs to investigate the modified product and provide a field evaluation label on the product. It is not anticipated that a field evaluation is needed to evaluate modifications that are identified in the instruction manual provided with the listed equipment, such as swapping out or adding listed modules. It is also not anticipated that a field evaluation is needed for like-for-like repairs that do not impair the overall safety of the product.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.2.4	314	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.2.4 Repurposed, Remanufactured, and Refurbished Batteries. **9.2.4.1*** This section covers batteries that have been repurposed, remanufactured, or refurbished. This includes batteries previously used in other applications, such as electric vehicle propulsion. **A.9.2.4.1** This section covers repurposed, remanufactured, and refurbished batteries used in ESS. “Repurposed” most often refers to batteries and battery modules previously used in electric vehicles.		

"Remanufactured" refers to rebuilt or refurbished batteries that have undergone a manufacturing type process to allow them to be used in an ESS application.

"Refurbished" refers to batteries used in an ESS application that are renovated or cleaned up so they can continue to be used in the same ESS application.

Regardless of whether a battery is repurposed, remanufactured, or refurbished, it may no longer be covered by the original battery OEM specifications and should undergo an evaluation to verify that it meets all applicable safety and performance requirements in this standard.

The requirements in this section are not intended to cover normal maintenance and testing operations on batteries conducted in accordance with the original battery OEMs instructions.

The replacement of worn-~~-~~out batteries with new OEM batteries in ESS is covered by the repair and retrofit requirements in 4.6.2 and 4.6.3.

9.2.4.2

ESS containing repurposed, remanufactured, or refurbished batteries shall comply with all applicable requirements in this standard for ESS containing new batteries.

9.2.4.~~1~~. 3

Batteries that have been repurposed, remanufactured, or refurbished shall meet the applicable technology-specific requirements in Table 9.6.5.

9.2.4.4

Refurbished batteries that are used in an application that (1) differs from the original use, or (2) have internal parts replaced or repaired shall be treated as remanufactured batteries and also comply with 4.2.4.5 and 4.2.4.6.

9.2.4.~~2~~ 5*

~~Batteries previously used in other applications, such as electric vehicle propulsion,~~ Repurposed batteries, remanufactured batteries, and the refurbished batteries covered by 9.2.4.4.1 shall not be permitted unless the equipment is repurposed or remanufactured by a ~~UL 1974–compliant battery repurposing company where reused in ESS applications and the system complies with 4.6.1~~company that is listed in accordance with UL 1974.

A.9.2.4.~~2~~ 5

UL 1974 is a factory process standard that 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 propulsion, and that are intended for a repurposed-use application, such as for use in energy storage systems. It includes requirements for quality control for factory facilities and processes such as sorting and grading, testing, and marking criteria for the batteries that are to be used in a new battery assembly. This standard is used for a facility process certification similar to ISO 9001. A battery that goes through this process is not a listed battery unless it is additionally evaluated to a safety standard such as UL 1973.

9.2.4.6*

The repurposed, or remanufactured batteries, modules and cells shall be provided with a nameplate marking that includes the electrical ratings, chemistry; model number; and manufacturer's identification.

	A.9.2.4.6 As part of the repurposing process, UL 1974 requires all markings from the original manufacturer (OEM) to be removed and replaced with markings provided as part of the re-purposing or remanufacturing of the batteries. This means there will be no markings that reference the battery OEM after the product has been repurposed.
First Revision Text (FR)	9.2.4 Repurposed, Remanufactured, and Refurbished Batteries. **9.2.4.1*** This section shall apply to batteries that have been repurposed, remanufactured, or refurbished. **A.9.2.4.1** This section covers repurposed, remanufactured, and refurbished batteries used in ESS. This includes batteries previously used in other applications, such as electric vehicle propulsion. “Repurposed” most often refers to batteries and battery modules previously used in electric vehicles. “Remanufactured” refers to rebuilt or refurbished batteries that have undergone a manufacturing type process to allow them to be used in an ESS application. “Refurbished” refers to batteries used in an ESS application that are renovated or cleaned up so they can continue to be used in the same ESS application. A battery that is repurposed, remanufactured, or refurbished may no longer be covered by the original battery OEM specifications and should undergo an evaluation to verify that it meets all applicable safety and performance requirements in this standard. The requirements in this section do not cover normal maintenance and testing operations on batteries conducted in accordance with the original battery OEMs instructions. The replacement of worn-out batteries with new OEM batteries in ESS is covered by the repair and retrofit requirements in 4.6.2 and 4.6.3. **9.2.4.2** ESS containing repurposed, remanufactured, or refurbished batteries shall comply with all applicable requirements in this standard for ESS containing new batteries. 9.2.4.3 Batteries that have been repurposed, remanufactured, or refurbished shall meet the applicable technology-specific requirements in Table 9.6.5. 9.2.4.4

	Refurbished batteries that are used in an application that differs from the original use, or have internal parts replaced or repaired shall: 1) comply with 9.2.4 for remanufactured batteries 2) comply with 4.2.4.5 and 4.2.4.6. 9.2.4.5* Repurposed batteries, remanufactured batteries, and the refurbished batteries covered by 9.2.4.4.1 shall not be permitted unless the equipment is repurposed by a company that is listed in accordance with UL 1974. A.9.2.4.5 UL 1974 is a factory process standard that 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 propulsion, and that are intended for a repurposed-use application, such as for use in energy storage systems. It includes requirements for quality control for factory facilities and processes such as sorting and grading, testing, and marking criteria for the batteries that are to be used in a new battery assembly. This standard is used for a facility process certification similar to ISO 9001. A battery that goes through this process is not a listed battery unless it is additionally evaluated to a safety standard such as UL 1973. 9.2.4.6* The repurposed, or remanufactured batteries, modules and cells shall be provided with a nameplate marking that includes the electrical ratings, chemistry; model number; and manufacturer's identification. A.9.2.4.6 As part of the repurposing process, UL 1974 requires all markings from the original manufacturer (OEM) to be removed and replaced with markings provided as part of the re-purposing or remanufacturing of the batteries. This means there will be no markings that reference the battery OEM after the product has been repurposed.
Statement (technical reason for FR)	This first revision provides a link to the repurposed, remanufactured, and refurbished battery section, a form of reused equipment. The balance of the proposed text, 9.2.4.3 through A9.2.4.6 is still being proposed.
Response (technical reason for not making some changes or for resolving)	

1.3.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	NONE		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	1.3.1* ESS shall comply with the requirements of this standard, as applicable. ~~A.1.3.1~~ ~~Where approved by the AHJ, alternate safety requirements can be applied for purpose of research, development, or testing.~~		
Statement (technical reason for FR)	The existing A.1.3.1 was removed because it is better covered under A.1.3.5		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 1.3.5	123,124 (annex)		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	1.3.5* This standard does not apply to product research, development, and testing conducted at laboratory occupancies and pilot plants. A.1.3.5 In some instances, such as for testing and research laboratories, Department of Energy National Laboratories, research universities and manufacturers engaged in product development, it is not possible to meet all prescriptive requirements of NFPA 855. The very nature of research, development, and testing typically precedes required listings such as UL 9540. Product research, development and testing activities still must comply with applicable codes, standards and safety protocols in relation to potential hazards presented by the laboratory activities.		
First Revision Text (FR)	1.3.5* Where approved by the AHJ, alternate safety measure shall be permitted to be applied for purpose of research, development, or testing. A.1.3.5		

	In some instances, such as for testing and research laboratories, Department of Energy National Laboratories, research universities and manufacturers engaged in product development, it is not possible to meet all prescriptive requirements of NFPA 855. The very nature of research, development, and testing typically precedes required listings such as UL 9540. Product research, development and testing activities still must comply with applicable codes, standards and safety protocols in relation to potential hazards presented by the laboratory activities. However, competent person review (including the possible requirement for an HMA) may drive the AHJ to require alternative safety measures.
Statement (technical reason for FR)	Labs doing testing need a way to test newer products not yet covered adequately by existing codes and standards.
Response (technical reason for not making some changes or for resolving)	The proposed language was too wide open in allowing anything to go into a lab or even pilot plant, without any fire safety professional or AHJ reviewing the possible hazards.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
15.4.1	157		☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	15.4.1 ESS shall only be installed in the following locations: (1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code (2) In detached garages and detached accessory structures (3) Outdoors on exterior walls or on the ground~~ located a minimum of 3 ft (914 mm) from doors and windows directly entering the dwelling unit~~. (4) In enclosed utility closets and storage or utility spaces where approved by the AHJ		

First Revision Text (FR)	15.4.1 ESS shall only be installed in the following locations: 1. In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code 2. In detached garages and detached accessory structures 3. Outdoors on exterior walls or on the ground located a minimum of 3 ft (914 mm) from doors and windows directly entering the dwelling unit In enclosed utility closets and storage or utility spaces where approved by the AHJ
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Li-ion batteries specifically have 3’ spacing rules elsewhere in this document, and sometimes even further separation from doors, walkways, etc. A better way to address the concern is to specifically encourage outdoor placement vs indoor, and away from the primary residential structure(s) if possible in the case of Li-ion.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
15.4.2	175	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	15.4.2 If the room or space where the ESS is to be installed is not finished or ~~noncombustible~~has combustible walls or ceilings, the unfinished or combustible walls and ceilings of the room or space shall be protected with not less than ⅝ in. Type X gypsum board.		
First Revision Text (FR)	15.4.2 If the room or space where the ESS is to be installed is not finished or has ~~non~~combustible walls or ceilings, the unfinished or combustible walls and ceilings of the room or space shall be protected with not less than 5⁄8 in. Type X gypsum board.		
Statement (technical reason for FR)	The existing text required Type X for all rooms. The section was revised to address "combustible" wood framing that is exposed. Additionally, wood paneling and other readily combustible wall coverings are the hazard to be addressed with the addition of Type X gypsum.		
Response (technical reason for not making some			

changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>Move 15.11 to 4.11</td><td>127, 128 (annex)</td><td>~~None~~126, 355 (TG5 for 4.11)</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">~~15~~ 4.11* Electric Vehicle Battery Use.
Utilizing electric vehicles to export power to premise wiring shall follow the requirements in Section 4.11.
A.4.11 Electric Vehicle Battery Use.
Electric vehicles can be used to supply power for backup use and a variety of grid support functions. Vehicle to Grid (V2G) applications typically require Permission To Operate (PTO) as they run in parallel with the utility. A potential gap exists regarding projects that use EV batteries with bidirectional EVSE, running in parallel with the distribution grid as generating facilities and with an interconnection agreement with the utility company, because they do not meet the existing definition of mobile ESS. In many respects, these installations are similar to those defined in section 3.3.9.5, mobile ESS used in a stationary situation. They are mobile battery packs that are being charged and discharged at a specific, permitted and interconnected location, and these facilities can easily reach multi-megawatt scale.
However, because the battery packs used in the V2G case are EV battery packs installed in EVs, they do not have the UL 9540 listing required for 855 compliance. There are no requirements for EV batteries to be listed to UL 1973 or 2580, and as a result, cannot be listed as a stationary ESS to UL 9540.
~~15~~ 4.11.1
The temporary use of the dwelling unit owner’s or occupant’s electric-powered vehicle to power the dwelling while parked in an attached or detached garage or outside shall comply with the vehicle manufacturer’s instructions and NFPA 70.
~~15~~ 4.11.2
Temporary emergency use of the dwelling unit owner’s or occupant’s electric-powered vehicle to power the dwelling while parked in an attached or detached garage or outside shall be permitted.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.11 * Vehicle to Grid (V2G) Usage.
A.4.11 Vehicle to Grid (V2G) Usage.
Electric vehicles can be used as ESS to supply power for backup use and a variety of grid support functions. Vehicle to Grid (V2G) applications typically require permission to operate (PTO) as they run in parallel with the utility. In many respects, these installations are similar to those defined in section 3.3.9.5, mobile ESS used in a stationary situation. They are mobile battery packs that are being charged and discharged at a specific, permitted and interconnected location, and these facilities can easily reach multi-megawatt scale.</td></tr>
</table>

	However, because the battery packs used in the V2G case are EV battery packs installed in EVs, they do not have the UL 9540 listing required for 855 compliance. There are no requirements for EV batteries to be listed to UL 1973 or 2580, and as a result, cannot be listed as a stationary ESS to UL 9540. 4.11.1 The temporary use of parked electric-powered vehicles as ESS to power commercial or industrial buildings or feed power back to the grid (where allowed and contracted with the local electric utility) shall comply with manufacturer's instructions and NFPA 70. 4.11.2 Temporary emergency use of parked electric-powered vehicles as ESS to power a commercial or industrial building or feed power back to the grid (where allowed and contracted with the local electric utility) shall be permitted.
Statement (technical reason for FR)	V2G is larger than just residential, and thus should be covered in Chapter 4, in addition to Chapter 15.
Response (technical reason for not making some changes or for resolving)	Most V2G applications would still be at the residential level, and thus the text in 15.11 kept.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	NONE		☐ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	15.11 * Electric Vehicle Battery Residential Use. A.15.11 Electric Vehicle Battery Residential Use This only applies to residential use of V2G or use of the vehicle battery for "house power". See Section 4.11 for requirements for commercial or industrial applications of V2G, 15.11.1 The temporary use of ~~the dwelling unit owner's or occupant's~~an electric-powered vehicle as an ESS to power the dwelling or feed power back to the grid where allowed and contracted with the local electric utility ~~while parked in an attached or~~		

	~~detached garage or outside~~ shall comply with the vehicle manufacturer's instructions and NFPA 70. 15.11.2 Temporary emergency use of ~~the~~ a parked ~~dwelling unit owner's or occupant's~~ electric-powered vehicle as an ESS to power the dwelling or feed power back to the grid (where allowed and contracted with the local electric utility). ~~while parked in an attached or detached garage or outside~~ shall be permitted.
Statement (technical reason for FR)	Most V2G applications would still be at the residential level. However, V2G is larger than just residential, and thus should be covered in Chapter 4, in addition to Chapter 15.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
A.1.4.2	88	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.1.4.2 ~~In order to help determine if an existing ESS installation presents an unacceptable risk and that retroactivity should apply, the AHJ can request~~ If an AHJ becomes aware of additional information regarding hazards due to an inspection, the AHJ shall be permitted to request that a hazard mitigation analysis be submitted by the owner in accordance with Section 4.4. Based on the hazardous mitigation analysis, the AHJ ~~can~~ shall be permitted to apply retroactively any portions of this standard deemed appropriate to mitigate any hazards that could be identified in the risk assessment as unacceptable.		
First Revision Text (FR)	1.4.2* In those cases where the authority having jurisdiction (AHJ) determines that an existing situation presents an unacceptable degree of risk, the AHJ shall be permitted to apply retroactively any portions of this standard deemed appropriate. A.1.4.2 ~~In order to help determine if an existing ESS installation presents an unacceptable risk and that retroactivity should apply, the~~If an AHJ becomes aware of additional information regarding hazards due to an inspection, the AHJ can request a hazard mitigation analysis be submitted by the owner in accordance with Section 4.4. Based on the hazardous mitigation analysis, the AHJ can ~~apply~~ retroactively apply any portions of this standard deemed appropriate to mitigate any hazards that could be identified in the risk assessment as unacceptable.		
Statement (technical reason for FR)	The first sentence was changed to describe how the potentially unsafe installations would be identified (typically via inspection).		
Response (technical reason for not making some changes or for resolving)	Requirements, including permissive requirements, cannot be in annex material.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.4.1	17	288, 135	☒~~☐~~ Create First Revision ☐ Resolve

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.4.1*
A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:
(1) Technologies not specifically addressed in Table 1.3 are provided
(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible
(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2
(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements
(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1
(6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1
(7) Where required by the AHJ for existing systems (retroactivity) in accordance with 1.4.2</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">4.4.1*
A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:
(1) Technologies not specifically addressed in Table 1.3 are provided
(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible
(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2
(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements
(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1
(6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1
(7) Where required by the AHJ for existing systems (retroactivity) in accordance with 1.4.2</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">This was done to strengthen the ability of an AHJ to call for review and possible modification of older systems installed before UL 9540 and 9540A certification/testing were available, due to the fires that have occurred at higher rates in these systems.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>4.4.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
</table>

	288	17, 135	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.4.1* A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present: (1) Technologies not specifically addressed in Table 1.3 are provided (2) ~~More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible~~ (3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2 (4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements (5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1 (6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	There are so many different potential adverse interactions, especially as technology evolves, that they need to be evaluated by a fire safety professional via an HMA to determine how truly dangerous or not they are. More guidance on "adverse" interactions is provided in new annex text.		
A.4.4.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	135, 136	~~136~~	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.4.4.1 One form of hazard mitigation analysis (HMA) is a failure mode and effects analysis (FMEA), which is a systematic technique for failure analysis. An FMEA is often the first step of a system reliability study and involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded. Other formal methodologies for conducting the analysis can also be used depending on the complexity and type of the system being assessed. Guidance for analysis can be found in the following standards: (1) IEC 60812 (2) IEC 61025		

	(3) MIL-STD-1629A The mixing of lead-acid batteries with nickel-cadmium batteries should not present a risk of adverse interaction. An HMA might not be necessary for these installations. Many ESS will be provided with safety equipment to meet the requirements of UL 9540, but in some circumstances additional safety equipment might need to be provided over and above what is included with the ESS. For example, an ESS installed indoors might depend upon exhaust ventilation provided with the installation in accordance with 9.6.5.1 to remove gases from the building. In this case, the HMA would need to address possible failures of such a system. It is not the intent of the HMA to evaluate the safety equipment provided as part of a listed ESS unless that equipment is installation dependent as determined by the testing to UL 9540 and UL 9540A. To clarification of "adverse" see Section 9.4.1.3 and Section 9.6.2.3.
First Revision Text (FR)	A.4.4.1 One form of hazard mitigation analysis (HMA) is a failure mode and effects analysis (FMEA), which is a systematic technique for failure analysis. An FMEA is often the first step of a system reliability study and involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded. Other formal methodologies for conducting the analysis can also be used depending on the complexity and type of the system being assessed. Guidance for analysis can be found in the following standards: (1) IEC 60812 (2) IEC 61025 (3) MIL-STD-1629A The mixing of lead-acid batteries with nickel-cadmium batteries ~~should~~ will not present a risk of adverse interaction. An HMA ~~might~~ is not ~~be~~ necessary for these installations. Many ESS will be provided with safety equipment to meet the requirements of UL 9540, but in some circumstances additional safety equipment might need to be provided over and above what is included with the ESS. For example, an ESS installed indoors might depend upon exhaust ventilation provided with the installation in accordance with 9.6.5.1 to remove gases from the building. In this case, the HMA would need to address possible failures of such a system. It is not the intent of the HMA to evaluate the safety equipment provided as part of a listed ESS unless that equipment is installation dependent as determined by the testing to UL 9540 and UL 9540A. Examples of potential adverse interactions between technologies that could increase safety risks, and thus merit the need for an HMA include adverse interactions from the leaking of flow battery anolytes and/or catholytes, chemical reactions that could occur from different off-gassing products from two different battery types, etc.

	There are also adverse interactions between technologies, such as a Li-ion fire that can damage other nearby technologies, but where safety risk is not increased, and thus an HMA may not be needed,
Statement (technical reason for FR)	There is a need to differentiate between adverse interactions that increase safety risks and those that do not (such as those that may affect only reliability), and thus examples were provided.
Response (technical reason for not making some changes or for resolving)	The proposed references to 9.4.1.3 and 9.6.2.3 do not describe adverse interactions, but simply give design parameters when technologies are mixed in the same fire area.

<table>
<tr><td>Section</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>New Chapter 16</td><td>107</td><td>None</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td></td><td></td><td></td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">Chapter 16 Flow Batteries
16.1
Flow battery installations shall comply with the requirements of this chapter and Chapters 4-9 as specified in Table 16.1.
Table 16.1 Flow Battery Installations</td></tr>
</table>

Compliance Required	Applies	Reference
Construction Documents	Yes	4.2
Emergency Planning and Training	Yes	4.3
HMA	Yes	4.4
Combustible Storage	Yes	4.5
Equipment	Yes	4.6
Installation	Yes	4.7
Smoke and Fire Detection	Yes	4.8
Fire Control and Suppression	Yes	4.9
Mobile ESS Equipment and Operations	Yes	4.10
System Interconnections	Yes	Chapter 5
Commissioning	Yes	Chapter 6
Operation and Maintenance	Yes	Chapter 7
Decommissioning	Yes	Chapter 8
General	Yes	9.1
Equipment	Yes	9.2
Location Classification	Yes	9.3
Maximum Stored Energy	Yes	9.4.1
Size and Separation	No	9.4.2
Location and Applications	Yes	9.5
Smoke and Fire Detection	Yes	9.6.1
Fire Control and suppression	Yes	9.6.2
Water Supply	No	9.6.3
Fire Barriers	Yes	9.6.4

Exhaust Ventilation	Yes	9.6.5.1
Spill Control	Yes	9.6.5.2
Neutralization	Yes	9.6.5.3
Safety Caps	No	9.6.5.4
Thermal Runaway	No	9.6.5.5
Explosion Control	No	9.6.5.6
Remediation Measures	No	9.6.6

16.2* Hazard Mitigation Analysis.

In addition to the failure modes in 4.4.2 the hazard mitigation analysis shall evaluate the consequences of an electrolyte containment system failure.

A.16.2

Sensitive site concerns may warrant additional containment provisions in addition to secondary containment systems that are part of the listed system. Examples could include environmental sensitivity or the risk associated with some elevated or rooftop installations.

16.3* Operation & Maintenance

The owner/operator shall confirm there are procedures in place for maintaining safety during servicing of stacks, pumps, fluid delivery systems, tanks and other serviceable components of a flow battery.

A.16.3

Flow batteries containing hazardous chemicals may need drainage or isolation of certain parts of the system in order to prevent unintentional release of chemicals during disassembly.

16.4 Decommissioning

16.4.1

Procedures for decommissioning of flow batteries shall follow manufacturer's instructions.

	16.4.2 If the decommissioning requires removal of electrolyte then the owner or their authorized agent shall ensure an entity has been assigned to be responsible for electrolyte removal and disposition upon decommissioning. **16.5 Fire Control and Suppression** Fire suppression agents used in rooms or areas that contain flow batteries shall be compatible with the flow battery materials and electrolytes. **16.6 Spill Control** **16.6.1** Where spill control is provided as part of the installation an alarm system shall be provided to signal an electrolyte leak from the system. **16.6.2** Where required, alarm signals shall be transmitted to an approved location. **16.7 Hazard Support Personnel.** Where required by the AHJ for public safety, the owner or their authorized agent shall provide hazard support personnel at the owner's expense.
Statement (technical reason for FR)	This new chapter addresses flow batteries rather than integrating this content into Chapter 9 to avoid confusion. There is enough unique content associated with flow batteries, such as pumps, stacks and large volume of electrolyte, that gets addressed by this chapter.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.1.3.2 A 6.1.3.2	91, 92		☒ Create First Revision ☐ Resolve

Proposed Text (PI)	
First Revision Text (FR)	6.1.3.2* The commissioning plan shall include, but not be limited to, the following information: (1) An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted (2) Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s) (3) Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s) (4) Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems (5) A detailed description of each activity to be conducted during the commissioning process, who will perform each activity, and at what point in time the activity is to be conducted (6) Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems (7) Testing for any required fire detection or suppression, spill detection and thermal management, ventilation, or exhaust systems associated with the installation and verification of proper operation of the safety controls (8) The following documentation: (a) Commissioning checklist (b) Relevant operational testing forms (c) Necessary commissioning logs (d) Progress reports (13) Means and methods whereby facility operation and maintenance staff will be trained on the system (14) Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system (15) A decommissioning plan meeting the provisions of Section 8.1 that covers the removal of the system from service and from the facility in which it is located and information on disposal of materials associated with each ESS A.6.1.3.2 Examples of the procedures to be used in documentation of the proper operation of the ESS and all associated operational controls and safety systems include the following: (1) ESS input and output power should track the commands. (2) ESS shuts down when shut-down command is sent. (3) Procedures for safe start up and shut down as described in 7.1.2(1) and procedures for inspection and testing of associated alarms, interlocks, and controls as described in 7.1.2(2) is made available at the start of commissioning.

Statement (technical reason for FR)	Where spill detection systems are provided, they should be tested. In the case of flow batteries, spill detection systems are an integral part of the safety systems.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.6.3.1 A. 4.6.3.1	90		☒ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	4.6.3.1* Retrofits of ESS shall be approved and comply with the following unless modified in other sections: 1. Battery systems and modules and capacitor systems and modules shall be listed in accordance with UL 1973 and installed in accordance with the manufacturer's instructions. 2. ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer's instructions. 3. The overall installation shall continue to comply with UL 9540 listing requirements, where applicable. Retrofits shall be documented in the maintenance, testing, and events log required in 4.2.3. A.4.6.3.1 Some flow batteries can be retrofitted with additional energy storage, discharge or recharge capacity without having to replace the entire battery. For example, additional energy storage could be added by replacing or adding more electrolyte tanks to an existing battery. The flow battery must remain in scope of the product listing in order to comply with 4.6.3.1.		
Statement (technical reason for FR)	The existing language in 4.6.3 is adequate for flow battery retrofits, however clarification is necessary to ensure that retrofits remain in compliance with their product listing after modification. This appendix note is intended to draw attention to how retrofits may be applied to flow batteries.		
Response (technical reason for			

not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.1.4*	94		☒ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	9.6.5.1.4* Natural Exhaust Ventilation. Exhaust ventilation shall be designed to limit the maximum concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume of the outdoor cabinet during the worst-case ~~event of~~ conditions including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards.		
Statement (technical reason for FR)	Flow batteries, and potentially other technologies may produce hydrogen during conditions other than charging. This change is intended to make these requirements broader in scope.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.1.5	95		☒ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	9.6.1.5 Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following: (1) Where hydrogen is the gas generated, an exhaust ventilation rate based on hydrogen generation estimates sufficient to limit the maximum		

	concentration of hydrogen to 1.0 percent of the total volume of the room, walk-in unit, or cabinet during the worst-case ~~event of~~ simultaneous "boost" charging of all the batteries, in accordance with nationally recognized standards (2) An exhaust ventilation rate based on the area of not less than 1 ft^3/min/ft^2 (5.1 L/sec/m^2) of floor area of the room, walk-in unit, enclosure, or cabinet
Statement (technical reason for FR)	Flow batteries, and potentially other technologies may produce hydrogen during conditions other than charging. This change makes these requirements broader in scope.
Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>13.1.3</td><td>198</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">13.1.3*
FESS shall not be installed in individual one- or two-family dwellings or in townhouse units~~.~~ unless the installation is designed by a registered design professional, is approved by the AHJ, and is maintained by a trained service provider when regular maintenance is required.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">13.1.3*
FESS shall not be installed in individual one- or two-family dwellings or in townhouse units unless the installation ~~is designed by a registered design professional, is approved by the AHJ, and is maintained by a trained service provider when regular maintenance is required.~~ complies with the following:
1) It is designed by a registered design professional
2) It~~,~~ is approved by the AHJ
~~1)~~3) It ~~, and~~ is maintained by a trained service provider when regular maintenance is required.
A.13.1.3
An FESS requires ongoing inspections and maintenance that might not occur with an individual homeowner installation unless following the guidance of Clause 13.1.3. A microgrid serving multiple dwellings assumes that required maintenance will be performed. Therefore, an FESS can be used as part of a multi-dwelling microgrid such as a neighborhood community solar installation.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The original clause was very limiting and could unnecessarily stifle technological and commercial development. No other technology in this standard is subject to this limitation. It is not clear why FESS should be disallowed from such installations provided they are designed and operated in a safe manner. It is understood that the existing building codes may not account for ESS installations and that there are concerns about homeowners performing any required regular maintenance. The revised wording addresses conditions under which the installation could be allowed.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
</table>

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
Table 13.2	199	None	☒~~☐~~ Create First Revision

☐ Resolve

Proposed Text (PI)

Table 13.2 FESS Technology-Specific Requirements

Compliance Required	~~Applicable Chapter Reference~~ Applies	~~Chapter 13 Modifications~~ Reference
Construction Documents	~~4.2~~ Yes	4.2.1.1 ~~applies~~ except as modified by 13.2.1 and 13.2.2
	~~-~~No	4.2.1.2 ~~– N/A~~
	~~-~~No	4.2.1.3~~– N/A~~
	~~-~~No	4.2.1.4~~– N/A~~
Emergency Planning and Training	~~4.3~~ Yes	4.3.2.1.4 applies except as noted in 13.2.2
	~~-~~No	4.3.2.1.5 ~~– N/A~~ (see 13.1.2)
~~Hazard mitigation analysis (~~HMA~~)~~	~~4.4~~ Yes	4.4.1 applies except as noted in 13.2.3
Fire and Explosion Testing	~~9.1.5~~ No	~~N/A~~ 9.1.5
Equipment	~~Section 4.6~~ Yes	4.6 See also 13.2.4 and 13.1.2
Retrofits	~~4.6.3~~ Yes	Except 4.6.3.2~~—N/A~~ and 4.6.3.3~~—N/A~~ (see 13.1.2)
Environments	~~4.6.7~~Yes	4.6.7 See also 13.2.5
Charge Controllers	~~4.6.8~~ No	~~N/A~~ 4.6.8
Energy Storage Management Systems	~~4.6.10~~ Yes	4.6.10 See also 13.2.6 and 13.2.6.1
Reused Equipment	~~4.6.5~~ No	~~N/A~~ 4.6.5
Seismic Protection	~~4.7.2~~ Yes	4.7.2 See also 13.2.7 and 13.2.7.1
Fire Barriers	~~9.6.4~~ No	~~N/A~~ 9.6.4
Elevation	~~4.7.7~~ No	~~N/A~~ 4.7.7 ~~(~~See 13.2.7.2~~)~~
Open Rack Installation	~~4.7.9~~ No	~~N/A~~ 4.7.9
ESS Dedicated Use Buildings	~~9.3.1.1~~ No	~~N/A~~ 9.3.1.1
Non-Dedicated Use Buildings	~~9.3.1.2~~ No	~~N/A~~ 9.3.1.2
Outdoor Installations	~~9.3.2~~ No	~~N/A~~ 9.3.2
Enclosures	~~4.6.12~~ Yes	4.6.12

		See also 13.2.8
Rooftop and Open Parking Garage Installations	~~9.5.3.1~~ No	~~N/A~~ 9.5.3.1 except as noted in 13.2.7, 13.2.7.1, and 13.2.7.2
Mobile ESS Equipment and Operations	~~9.5.3.2~~ Yes	9.5.3.2 ~~applies(~~See 13.2.9~~)~~
	~~-~~No	9.5.3.2.1.2 ~~-N/A~~
	~~-~~No	9.5.3.2.2.2 ~~– N/A~~
	~~-~~No	9.5.3.2.5.3 ~~– N/A~~
	~~-~~No	9.5.3.2.6 ~~– N/A; requirements for deployed mobile FESS in accordance with Chapter 13~~
Size and Separation	~~9.4.2~~ No	~~N/A~~ 9.4.2
Maximum Stored Energy	~~9.4.1~~ No	~~N/A~~ 9.4.1
Exhaust Ventilation	~~9.6.5.1~~ No	~~N/A~~ 9.6.5.1
Smoke and Fire Detection	~~Section 4.8~~ No	~~N/A~~ 4.8 ~~(~~See 13.2.10~~)~~
Fire Control and Suppression	~~Section 4.9~~ No	~~N/A~~ 4.9 ~~(~~See 13.2.11~~)~~
Explosion Control	~~9.6.5.6~~ No	~~N/A~~ 9.6.5.6 ~~(~~See 13.2.8~~)~~
Water Supply	~~4.9.4~~ No	~~N/A~~ 4.9.4
System Interconnection	~~Chapter 5~~ Yes	5
	No	~~Section~~ 5.3~~—N/A~~
Commissioning	~~Chapter 6~~ Yes	6 See also Section 13.3
Operation and Maintenance	~~Chapter 7~~ Yes	7 See also Section 13.4
	~~-~~No	7.1.3~~– N/A~~
Decommissioning	~~Chapter 8~~ Yes	8 See also Section 13.5

First Revision Text (FR)

Table 13.2 FESS Technology-Specific Requirements

Compliance Required	~~Applicable Chapter Reference~~Applies	~~Chapter 13 Modifications~~Reference
Construction documents	Yes~~4.2~~	4.2.1.1~~ applies~~ except as modified in 13.2.1 and 13.2.2
	No	4.2.1.2~~ — N/A~~

	No	4.2.1.3~~ N/A~~
	No	4.2.1.4~~ N/A~~
Emergency planning and training	~~4.3~~Yes	4.3.2.1.4 applies except as noted in 13.2.2
	No	4.3.2.1.5~~ N/A~~ *(see 13.1.2)*
Hazard mitigation analysis (HMA)	~~4.4~~Yes	4.4.1 applies except as noted in 13.2.3
Fire and explosion testing	~~9.1.5~~No	~~N/A~~9.1.5
Equipment	~~Section 4.6~~Yes	4.6 See also 13.2.4 and 13.1.2
Retrofits	~~4.6.3~~Yes	Except 4.6.3.2 ~~ N/A~~ and 4.6.3.3~~ N/A~~ *(see 13.1.2)*
Environment	~~4.6.7~~Yes	4.6.7 See also 13.2.5
Charge controllers	~~4.6.8~~ No	~~N/A~~4.6.8
Energy storage management systems	~~4.6.10~~Yes	4.6.10 See also 13.2.6 and 13.2.6.1
Reused equipment	~~4.6.5~~No	~~N/A~~4.6.5
Seismic protection	~~4.7.2~~Yes	4.7.2 See also 13.2.7 and 13.2.7.1
Fire barriers	~~9.6.4~~No	~~N/A~~9.6.4
Elevation	~~4.7.7~~No	~~N/A~~ 4.7.7 ~~(~~S~~s~~ee 13.2.7.2~~)~~
Open rack installation	~~4.7.9~~No	~~N/A~~4.7.9
ESS dedicated-use buildings	~~9.3.1.1~~No	~~N/A~~9.3.1.1
Non-dedicated-use buildings	~~9.3.1.2~~No	~~N/A~~9.3.1.2
Outdoor installations	~~9.3.2~~No	~~N/A~~9.3.2
Enclosures	~~4.6.12~~Yes	4.6.12 See also 13.2.8
Rooftop and open parking garage installations	~~9.5.3.1~~No	~~N/A~~9.5.3.1 except as noted in 13.2.7, 13.2.7.1, and 13.2.7.2
Mobile ESS equipment and operations	~~9.5.3.2~~Yes	9.5.3.2 See 13.2.9 ~~9.5.3.2.1.2 N/A~~
	No	9.5.3.2.1.2 ~~applies *(see 13.2.9)*~~
	No	9.5.3.2.2.2~~ N/A~~
	No	9.5.3.2.5.3~~ N/A~~
	No	9.5.3.2.6~~ N/A; requirements for deployed mobile FESS in accordance with Chapter 13~~
Size and separation	~~9.4.2~~No	~~N/A~~9.4.2
Maximum stored energy	~~9.4.1~~No	~~N/A~~9.4.1
Exhaust ventilation	~~9.6.5.1~~No	~~N/A~~9.6.5.1
Smoke and fire detection	~~Section 4.8~~No	4.8 ~~N/A (s~~ *See 13.2.10*~~)~~
Fire control and suppression	~~Section 4.9~~No	4.9~~N/A (s~~ See 13.2.11~~)~~

Explosion control	~~9.6.5.6~~No	9.6.5.6~~N/A (s~~ See 13.2.8~~)~~
Water supply	~~4.9.4~~No	~~N/A~~4.9.4
System interconnection	~~Chapter 5~~Yes No	5 ~~Section~~ 5.3~~ N/A~~
Commissioning	~~Chapter 6~~Yes	6 See also Section 13.3
Operation and maintenance	~~Chapter 7~~Yes	7 See also Section 13.4
	No	7.1.3~~ N/A~~
Decommissioning	~~Chapter 8~~Yes	8 See also Section 13.5

~~N/A: Not applicable.~~

Statement (technical reason for FR)	The table, in its current form, is not clear as to whether the referenced sections apply or not. It is difficult to know without further explanation. The revised table makes the table easier to interpret. The format is chosen to match the format of other tables.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
13.2.5	200	206	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	13.2.5* FESS shall not be installed in locations ~~locations that could stress the bearing systems and impact their operation.~~ where high levels of ground vibration (not including seismic vibration) are transmitted to the operating flywheel and its bearings unless means are provided to limit the vibrations within acceptable limits for the FESS and the installation is evaluated by a registered design professional.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	The original clause is too vague and may be unnecessarily limiting. This revision adds wording that is consistent with the annex but with the clarification that the vibrations must actually be transmitted to the flywheel. It is possible to greatly reduce transmitted vibration in the design of the flywheel mounting so that they do not create stress on the bearings.
Response (technical reason for not making some	

changes or for resolving)			
A.13.2.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	206	200	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.13.2.5 Locations subject to high levels of vibration, such as near train tracks or large engine generators) can result in stress to the bearing systems and affect the safe operation of the FESS. However, FESS may be designed with some level of vibration dampening such that not all vibrations are transmitted to the flywheel. A flywheel could be installed in such a location when it can be shown that the transmitted vibration levels are low and will not affect the bearings.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	The original clause is too vague and may be unnecessarily limiting. This revision adds wording that is consistent with the annex but with the clarification that the vibrations must actually be transmitted to the flywheel. It is possible to greatly reduce transmitted vibration in the design of the flywheel mounting so that they do not create stress on the bearings.		
Response (technical reason for not making some changes or for resolving)			
First Revision Text (FR)	13.2.5* FESS shall not be installed in locations where high levels of ground vibration (not including seismic vibration) are transmitted to the operating flywheel and its bearings unless the following conditions are met: 1) Means are provided to limit the vibrations within acceptable limits for the FESS 2) The installation is evaluated by a registered design professional. ~~locations that could stress the bearing systems and impact their operation.~~ A.13.2.5 Locations subject to high levels of vibration, such as near train tracks or large engine generators) can result in stress to the bearing systems and affect the safe operation of the FESS. However, FESS may be designed with some level of vibration dampening such that not all vibrations are transmitted to the flywheel. A flywheel could be installed in such a location when it can be shown that the transmitted vibration levels are low and will not affect the bearings.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
13.2.6	201	346	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	13.2.6* The energy storage management system (ESMS) of a FESS shall~~ include bearing monitoring for magnetic bearings.~~ include bearing monitoring for magnetic bearings. ~~However, FESS may be designed with some level of vibration dampening such that not all vibrations are transmitted to the flywheel. A flywheel could be installed in such a location when it can be shown that the transmitted vibration levels are low and will not affect the bearings.~~ 13.2.6.1 There shall be some means (e.g., alarm, hazard light, warning signal to control panel) to annunciate when bearing maintenance, repairs, or changes are due. 13.2.6.2* The ESMS shall monitor and record temperature and vibration of the FESS.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This requirement should be covered by the product standard, not the installation standard.		
13.2.6	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	346	201	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	~~13.2.6*~~ ~~The energy storage management system (ESMS) of a FESS shall include bearing monitoring for magnetic bearings.~~ ~~13.2.6.1~~ ~~There shall be some means (e.g., alarm, hazard light, warning signal to control panel) to annunciate when bearing changes are due.~~ ~~13.2.6.2*~~ ~~The ESMS shall monitor and record temperature and vibration of the FESS.~~		

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	These are design features of the ESS and if essential, they should be covered by the listing standard. Clause 15.3 of UL 9540, Ed 3 covers this requirement.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	~~13.2.6*~~ ~~The energy storage management system (ESMS) of a FESS shall include bearing monitoring for magnetic bearings.~~ ~~A.13.2.6~~ ~~There should be capability for the ESMS to track the bearing replacement based upon length of date in service or usage (whichever comes first) and that incorporates the time the bearings are without magnetic unloading, which can reduce bearing life. The bearing monitoring can be part of the flywheel control system.~~ ~~13.2.6.1~~ ~~There shall be some means (e.g., alarm, hazard light, warning signal to control panel) to annunciate when bearing changes are due.~~ ~~13.2.6.2*~~ ~~The ESMS shall monitor and record temperature and vibration of the FESS.~~ ~~A.13.2.6.2~~ ~~ESMS data on temperature and vibration should be stored for postfailure analysis.~~

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
13.2.7.1	202	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	13.2.7.1 The seismic ratings of the FESS and suitability of ~~mounting means shall be~~ the seismic mounting means shall be determined by a registered design professional prior to installation and verified during installation.		

First Revision Text (FR)	13.2.7.1 The seismic ratings of the FESS and suitability of the seismic mounting means shall be determined by a registered design professional prior to installation and ~~mounting means shall be~~ verified during installation.
Statement (technical reason for FR)	Seismic ratings and anchoring are usually determined by a qualified structural engineer before the installation occurs.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New A.13.2.10	207	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.13.2.10 The smoke and fire detection requirements of section 4.8 do not apply to FESS because FESS do not present a fire hazard. Follow applicable local building codes where they exist.		
First Revision Text (FR)	13.2.10* Smoke and fire detection for FESS installations shall be in accordance with the local building code. A.13.2.10 The smoke and fire detection requirements of section 4.8 do not apply to FESS because FESS do not present a fire hazard. Follow applicable local building codes where they exist.		
Statement (technical reason for FR)	This revision adds an annex explanation regarding the intention of the clause.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

New A.13.2.11	208	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	A.13.2.11 The fire control and suppression requirements of 4.9 do not apply to FESS because FESS do not present a fire hazard. Follow applicable local building codes where they exist.		
First Revision Text (FR)	13.2.11* Fire control and suppression for FESS installation shall be in accordance with the local building code. A.13.2.11 The fire control and suppression requirements of Section 4.9 do not apply to FESS because FESS do not present a fire hazard. Follow applicable local building codes where they exist.		
Statement (technical reason for FR)	This revision adds an annex explanation regarding the intention of the clause.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
13.2.12	203	212	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	13.2.12* Separation or barriers shall be used to ensure that catastrophic failure of a flywheel does not propagate to other flywheels or energy storage systems in the area unless the flywheel design and its production quality controls mitigate the risk of sudden flywheel rupture or if a rupture can be contained completely within the primary flywheel housing.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	The size and separation requirements of 9.4.2 do not apply as shown in Table 13.2. Also, UL 9540 deals with design, securement, and containment of flywheels in the event of a fault. Such barriers should not be necessary with proper design, securement, and containment.		
Response (technical reason for not making some			

<table>
<tr><td>changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">A.13.2.12</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>212</td><td>203</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.13.2.12

Parts or other debris from catastrophic failure of a flywheel could damage adjacent flywheels or energy storage systems if the housing does not fully contain the failure. Annex note 13.2.8 references two containment measures, housing containment or stringent rotor screening in production. Containment of a rotor burst within the primary flywheel housing means that no primary or secondary particles leave the space defined by the housing if the rotor ruptures. The risk of rotor rupture can be greatly mitigated by ensuring that the rotor design and its materials prevent rapid propagation of any cracks that could result in a sudden rupture. Or, alternatively, the risk of rotor rupture can be greatly mitigated with controls, if the design and monitoring system make the cracked condition detectable before a rupture can occur. Risk mitigation can be realized with stringent production controls put in place to verify that each rotor and its material meet the requirements needed to prevent sudden rupture. The production controls generally include regular destructive sampling of actual production pieces and subjecting them to ASTM or other standard tests to verify actual physical properties, and 100% non-destructive testing (ultrasound and surface inspections) of production rotors.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The size and separation requirements of 9.4.2 are shown as N/A in Table 13.2. Also, UL 9540 deals with design, securement, and containment of flywheels in the event of a fault. Such barriers should not be necessary with proper design, securement, and containment.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">13.2.12*

Separation or barriers shall be used to ensure that catastrophic failure of a flywheel does not propagate to other flywheels or energy storage systems in the area unless it complies with one of the following:

1) the flywheel design and its production quality controls mitigate the risk of sudden flywheel rupture or
~~1)~~2) ~~if~~ a rupture can be contained completely within the primary flywheel housing.

A.13.2.12</td></tr>
</table>

	Parts or other debris from catastrophic failure of a flywheel could damage adjacent flywheels or energy storage systems if the housing does not fully contain the failure. Annex ~~note~~ A.13.2.8 references two containment measures, housing containment or stringent rotor screening in production. Containment of a rotor burst within the primary flywheel housing means that no primary or secondary particles leave the space defined by the housing if the rotor ruptures. The risk of rotor rupture can be greatly mitigated by ensuring that the rotor design and its materials prevent rapid propagation of any cracks that could result in a sudden rupture. ~~Or, a~~Alternatively, the risk of rotor rupture can be greatly mitigated with controls, if the design and monitoring system make the cracked condition detectable before a rupture can occur. Risk mitigation can be realized with stringent production controls put in place to verify that each rotor and its material meet the requirements needed to prevent sudden rupture. The production controls generally include regular destructive sampling of actual production pieces and subjecting them to ASTM or other standard tests to verify actual physical properties, and 100% non-destructive testing (ultrasound and surface inspections) of production rotors.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
13.3	204	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	13.3* Commissioning. Prior to commissioning, correct installation ~~for mechanical securement and containment~~ per manufacturer's specifications shall be confirmed.		
First Revision Text (FR)	13.3* Commissioning. Prior to commissioning, correct installation ~~per~~in accordance with manufacturer's specifications~~for mechanical securement and containment~~ shall be confirmed. ~~A.13.3~~ ~~Prior to operating the FESS, the following should be verified to ensure that the bolts securing the FESS are the correct grade and size, and are all torqued to specification; the concrete inserts are the correct type; the concrete support is the appropriate thickness (validate with personnel that did the coring); and the proper mechanical containment was installed, if required. As part of this process, the securement of the bolts should be reverified to ensure that they are tightened to the appropriate torque.~~		
Statement (technical reason for FR)	The manufacturer's specifications should account for proper securement and containment. Thus, the annex is no longer needed.		

Response (technical reason for not making some changes or for resolving)	

<table>
<tr><th>Section</th><th>All PIs used for FR or Resolve</th><th>Other PIs that propose revisions for this section</th><th>MOTION</th></tr>
<tr><td>13.4</td><td>205</td><td>None</td><td>☒~~☐~~ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">13.4* Operation and Maintenance.
~~As part of routine maintenance there shall be~~ The FESS operator shall provide systems and/or procedures for monitoring ~~/checking for bearing wear.~~ bearing condition information provided by the ESMS.
13.4.1
During installation, the ~~AHJ shall confirm that the maintenance procedures have both a process for determining the bearing change interval and follow-up procedures.~~ operator shall confirm that there is a process or system for determining bearing condition and that there is a process for determining when the bearings must be repaired or replaced.
13.4.2*
The ~~AHJ~~ operator shall confirm that the maintenance procedures include a check of the status of the ~~vacuum on a periodic basis.~~ flywheel vacuum system status on a periodic basis when a vacuum system is employed and where loss of vacuum presents a safety hazard.
13.4.3 Spin Down.
13.4.3.1
The maximum time to spin down shall be included in the maintenance documentation to ensure that the rotor has coasted down to zero prior to maintenance or moving the FESS.
13.4.3.2
The technician shall make certain that they have confirmed the maximum spin down time for safety reasons.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">13.4~~*~~ Operation and Maintenance.
~~As part of routine maintenance there shall be procedures for monitoring/checking for bearing wear.~~
13.4.1*
During installation, the operator shall confirm that there is a process or system for determining bearing condition and that there is a process for determining when the bearings must be repaired or replaced. ~~AHJ shall confirm that the~~</td></tr>
</table>

	~~maintenance procedures have both a process for determining the bearing change interval and follow-up procedures.~~ A.13.4.1 The bearing change interval can be either periodic or reported by the system. If reported by the system, it should be based upon actual bearing condition. 13.4.2* The AHJ shall confirm that the maintenance procedures include a check of the status of the vacuum on a periodic basis, if a vacuum system is employed and where loss of vacuum presents a safety hazard. A.13.4.2 Vacuum leaks often get worse over time and a leak should be dealt with preemptively. With some designs of FESS, a sudden loss of vacuum can result in a rotor failure. 13.4.3 Spin Down. 13.4.3.1 The maximum time to spin down shall be included in the maintenance documentation to ensure that the rotor has coasted down to zero prior to maintenance or moving the FESS. 13.4.3.2 The technician shall make certain that they have confirmed the maximum spin down time for safety reasons.
Statement (technical reason for FR)	For 13.4.1, it is often not practical to monitor or check bearing wear. Condition monitoring in this case means that there is a system or procedure in place for routine surveillance of bearing related FESS measurements and messages. Also, the wording was revised to be more general because bearings may be made from other than mechanical technologies such as magnetic or air bearings. For 13.4.1, the AHJ may not be qualified for these activities, so “AHJ” was changed to “operator”. Existing A.13.4 was moved to match the corresponding Section 13.4.1.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	238	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	3.x Energy Storage System Limited-Production Certification (LPC): Performed by Recognized Laboratories for Energy Storage Systems to verify compliance of the requirements of Appropriate Test Standard, the Limited Production Certification process enables system integrators, original equipment manufacturers, to field assemble, test, commission, and certify energy storage systems as satisfying the requirements of the Appropriate Test Standard.		
First Revision Text (FR)	3.x Energy Storage System Limited-Production Certification (LPC): A process that enables system integrators, original equipment manufacturers, to field assemble, test, commission, and certify energy storage systems as satisfying the requirements of the appropriate test standard.		
Statement (technical reason for FR)	An LPC is a viable pathway for certification of BESS system that are limited in number of units produced. It may also apply to due to production methodologies, such as different sub listings and manufacturing facilities cannot meet the UL 9540 requirements for listing a system.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	240	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	3.x Appropriate Test Standard: A document which specifies the safety requirements for specific equipment or class of equipment and satisfies the requirements of 29 CFR 1910.7(C).		
First Revision Text (FR)	3.x Appropriate Test Standard: A document which specifies the safety requirements for specific equipment or class of equipment and satisfies the requirements of 29 CFR 1910.7(C).		
Statement (technical reason for FR)	While the intent of the 855 standard the requirements of the UL 9540 listing is to provide a BESS product that meets this standard through product components and fabrication production that is appropriately evaluated and found acceptable at a production level. This is not consistently happening to provide 9540 listings because of products that are stick built in the field, Products that have multiple fabrications points such as the batteries and modules that are manufactured in Asia, the containers are integrated in South American, and the finishing touches are completed on a clients site in the US. Or certain completed components are not part of the manufacturer's products such as the requirements for a UL listed inverter. Or the batteries have been repurposed and production pathways are no longer viable to evaluate. Because of these issue production listings are not always achievable through manufacturing, so therefore it doesn't		

	happen. Additional options are and should be available for ensuring a “listing”. By providing definitions and clarification around listings, it provides a better compliance options for a system that lacks options for successful compliance.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	241	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	3.x ESS Field Evaluation: Performed by an AC354 Accredited Field Evaluation Body (FEB) as approved by the authority having jurisdiction, an Energy Storage System Field Evaluation is based on Appropriate Test Standard to verify the failure of structures, systems, or components do not result in fire, electrical shock, or injury of personnel. The ESS Field Evaluation is the process used to determine conformance with requirements for one-of-a-kind, limited-production, used, or modified products that are not listed or labeled under a certification program. A.3.xx The International Accreditation Service® (IAS) verifies the competency of independent, third-party accreditation of field evaluation bodies (FEBs) using Accreditation Criteria for Field Evaluation of Unlisted Electrical Equipment (AC354). The AC354 accreditation process requires each FEB to demonstrate compliance with both NFPA 790 and NFPA 791. Field Evaluations do not verify compliance to the Appropriate Test Standard.		
First Revision Text (FR)	3.x ESS Field Evaluation: An energy storage system field evaluation is based on an appropriate test standard to verify the failure of structures, systems, or components do not result in fire, electrical shock, or injury of personnel. A.3.xx The ESS field evaluation is the process used to determine conformance with requirements for one-of-a-kind, limited-production, used, or modified products that are not listed or labeled under a certification program. The International Accreditation Service® (IAS) verifies the competency of independent, third-party accreditation of field evaluation bodies (FEBs) using Accreditation Criteria for Field Evaluation of Unlisted Electrical Equipment (AC354). The AC354 accreditation process requires each FEB to demonstrate compliance with both NFPA 790 and NFPA 791. Field evaluations do not verify compliance to the appropriate test standard.		
Statement (technical reason for FR)	This definition aligns with new 4.6.2 on field evaluations. This provides an alternate method of compliance with UL 9540 without lessening safety when due to production methods or separate listing such as UL 1741, UL 1973 and separate evaluations that UL 9540 cannot be accomplish. The technical committee is seeking public comment as it is applicable to repurposed batteries that do not have a UL 1973 listing.		
Response (technical reason for			

not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	242	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	3.x Recognized Laboratory: an organization that is approved by OSHA as meeting the requirements of 29CFR 1910.7 to provide independent third-party product safety testing in accordance with Appropriate Test Standards and certification of compliance thereof.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This definition is not required as it is taken care with existing definitions and labeling,		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	243	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	Listed Energy Storage System. equipment, materials, or services included in a list published by an Recognized Laboratory concerned with evaluation of energy storage products or services, that maintains periodic inspection of production of listed energy storage equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service that satisfies the minimum requirements of Appropriate Test Standard		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some	This definition is not required as it taken care with existing definitions and labeling,		

changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.6.1	164, 244	~~244~~	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	4.6.1* Listings. ESS shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard. ESS that are not listed in accordance with UL 9540 should be documented and verified by an approved third-party certification organization as meeting the provisions of this standard using the equivalency requirements in Section 1.5, where technical documentation provided shows the ESS that is proposed results in a system that is no less safe than a system meeting the construction and performance requirements of UL 9540.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	Covered by first revision in Guidance document 4.6.2.		
~~4.6.1~~	~~All PIs used for FR or Resolve~~	~~Other PIs that propose revisions for this section~~	~~MOTION~~
	~~244~~	~~164~~	~~☐ Create First Revision~~ ~~☒☐ Resolve~~
Proposed Text (PI)	4.6.1* Listings. ESS shall be ~~listed~~ evaluated, tested and listed by a recognized laboratory in accordance with the appropriate test standard (UL 9540), unless specifically exempted in other sections of this standard.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	Covered by first revision in Guidance document 4.6.2.		

<table>
<tr><td rowspan="2">A.4.6.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>163, 245</td><td>~~245~~</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.6.1
It is envisioned that equipment provided will be listed in accordance with UL 9540. ESS that are not listed in accordance with UL 9540 should be documented and verified by an approved third-party certification organization as meeting the provisions of this standard using the equivalency requirements in Section 1.5, where technical documentation provided shows the ESS that is proposed results in a system that is no less safe than a system meeting the construction and performance requirements of UL 9540. ~~If nonlisted equipment is to be evaluated for compliance with UL 9540, the evaluation and documentation should be provided as part of a field evaluation conducted by an approved third-party certification organization.~~
In specific instances, this standard will not require equipment such as lead-acid batteries to be listed or they can be listed to UL 1973 instead of UL 9540.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">Covered by first revision in Guidance document 4.6.2.</td></tr>
<tr><td rowspan="2">~~A.4.6.1~~</td><td>~~All PIs used for FR or Resolve~~</td><td>~~Other PIs that propose revisions for this section~~</td><td>~~MOTION~~</td></tr>
<tr><td>~~245~~</td><td>~~163~~</td><td>~~☐ Create First Revision~~
☒~~☐ Resolve~~</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.6.1
It is envisioned that equipment provided will be listed in accordance with the appropriate test standard (UL 9540) or an equivalent AHJ approved process by a recognized laboratory. ESS that are not listed in accordance with UL 9540 should be documented and verified as meeting the provisions of this standard using the equivalency requirements in Section 1.5, where technical documentation provided shows the ESS that is proposed results in a system that is no less safe than a system meeting the construction and performance requirements of UL 9540. If nonlisted equipment is to be evaluated for compliance with UL 9540, the evaluation and documentation should be provided as part of a Limited production certification (LPC) process or an AHJ approved field evaluation conducted by an OSHA approved recognized laboratory or third-party certification organization.
In specific instances, this standard will not require equipment such as lead-acid batteries to be listed or they can be listed to UL 1973 instead of UL 9540.</td></tr>
</table>

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Resolved with 163.
First Revision Text (FR)	4.6.1* Listings. ESS shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard. A.4.6.1 It is envisioned that the equipment provided will be listed in accordance with UL 9540. ESS that are not listed in accordance with UL 9540 should be documented and verified as meeting the provisions of this standard using the equivalency requirements in Section 1.5, where technical documentation provided shows the ESS that is proposed results in a system that is no less safe than a system meeting the construction and performance requirements of UL 9540. If nonlisted equipment is to be evaluated for compliance with UL 9540, the evaluation and documentation should be provided as part of a field evaluation conducted by an approved third-party certification organization. In specific instances, this standard will not require equipment such as lead-acid batteries to be listed or they can be listed to UL 1973 instead of UL 9540.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.2.1.1	247	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	9.2.1.1 ESS shall be evaluated, tested and listed by a recognized laboratory in accordance with the appropriate test standard (UL 9540), unless specifically exempted elsewhere in this standard.		
First Revision Text (FR)			
Statement (technical reason for FR)			

Response (technical reason for not making some changes or for resolving)	Proposed changes do not improve the language.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New A.9.2.2.1	248	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	9.2.2.1* Existing lithium-ion ESS that are not UL 9540 listed shall require a hazard mitigation analysis in accordance with Section 4.4. A.9.2.2.1 Hazard Mitigation Analysis (HMA) for non-listed ESS shall follow the guidelines of Annex G. The HMA shall specifically address the sections of the Appropriate Standard not evaluated by the Recognized Laboratory to identify the risks of the omitted sections, evaluate the efficacy of the associated engineering or administrative controls, and effectiveness of the proposed hazard mitigation measures that precludes the likelihood of fire, shock or injury to personnel.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This issue is resolved by the clarification of the HMA requirements in the body of the standard for non-listed and field evaluation systems.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.5.2	250	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	9.6.5.5.2 Thermal runaway protection shall be permitted to be provided by the battery management system or a capacitor ESS management system that has been evaluated as part of the UL 1973, ~~or~~ UL 9540 listing or AHJ approved equivalent certification process.		
First Revision Text (FR)			

Statement (technical reason for FR)	The submitter did not provide any data to support adding an equivalent standard and what that standard may be. Additionally, this would put the responsibility on AHJ who is not a~~n~~ certifying agency.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Section 4.6.2	CI		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	**4.6.2 * Field evaluations.** The AHJ is authorized to approve an ESS that is not listed in accordance with 4.6.1 using a field evaluation that complies with this section. **A.4.6.2**. Energy storage systems (ESS), with a few exceptions for certain lead-acid ESS, are required to be listed in accordance with UL 9540. This is a very complex standard with detailed construction, performance (testing) and functional safety requirements that cover the ESS, including cells, modules, controls, battery management system, and the overall system interaction. Because of the complexity of the UL 9540 requirements, this proposal puts guard rails in place for situations where ESS is present at an installation site that has not been listed to UL 9540, and a field evaluation is being considered by the AHJ for approving the ESS. The requirements in this section form the technical basis for how the requirements in Section 1.5 are to be applied to determine equivalency to a UL 9540 listing. **4.6.2.1 Documentation.** The owner or their authorized agent shall provide at no charge to the AHJ documentation showing compliance with all 4.6.2 requirements. **4.6.2.2 * Approved agencies.** The field evaluation shall be conducted by one of the following approved agencies: 1. A Nationally Recognized Testing Laboratory (NRTL) ~~1.~~2. A certification organization accredited in accordance with IEC/ISO 17065 for providing UL 9540 certifications, or		

3. A Field Evaluation Body (FEB) accredited in accordance with NFPA 790 for evaluating energy storage systems in accordance with UL 9540.

A.4.6.2.2 Due to the complex nature of UL 9540 construction, performance and functional safety requirements, and the UL 9540A fire propagation testing requirements that are incorporated in UL 9540, field evaluations of ESS need to be performed by a competent, qualified organizations and individuals. This section identifies the qualifications of agencies that can perform UL 9540 field evaluations. This includes accredited certification organizations and accredited field evaluation bodies.

The NFPA 790 *Standard for Competency of Third-Party Field Evaluation Bodies* includes general requirements for the qualification and competency of a body performing field evaluations on electrical products and assemblies with electrical components. However, there are no specific qualifications identified for FEB that conduct field evaluations of ESS, and these can be categorized under the Appendix C electrical products groups as “Other similar electrical products”. A careful review of the FEB qualifications for conducting ESS field evaluations should be considered.

The NFPA 791 *Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation* provides recommended procedures for evaluating unlabeled electrical equipment in conjunction with nationally recognized standard(s) applicable to the subject equipment and any requirements of the AHJ.

4.6.2.3 UL9540 Evaluation.

The field evaluation shall evaluate the ESS for compliance for all UL 9540 construction, technical, performance, quality, and functional safety requirements. Any deviation from UL9540 shall be identified in the field evaluation report and approved by the AHJ.

4.6.2.4 * Functional Safety.

The functional safety review and analysis of ESS in support of the field evaluation shall include documentation demonstrating the FEB’s compliance with the qualification criteria in UL 9540.

A.4.6.2.4 The standards referred in UL 1973 and UL 9540 for functional safety are:

a) UL 991 and UL 1998;
c) Annex H of UL 60730-1 (Function Class B requirements);
d) IEC 61508 (all parts) (minimum of Safety Integrity Level (SIL) "2" requirements for active protective devices with software controls);
e) ISO 13849-1 and ISO 13849-2 (minimum of Performance Level (PL) "c" requirements for active protective devices with software controls); or

	f) ISO 26262 (all parts) (minimum Automotive Safety Integrity Level (ASIL) "C" requirements for active protective devices with software controls). **4.6.2.5 * Battery listings.** All battery cells, modules or rack-mounted-modules in the ESS shall be listed and labeled in accordance with UL 1973. **A.4.6.2.5** Several AHJs have expressed interest in having the battery cells, modules or rack-mounted modules covered by a factory audit inspection program. Requiring these components to be listed and labeled in accordance with UL 1973 includes this factory surveillance. In addition, the UL 1973 covers not only the cells, but also covers the battery management system and other safeguards. Numerous BESS fires have been attributed to poorly manufactured Li-Ion battery cells (contaminants, damaged membranes, inadequate spacings). To minimize these problems, this section mandates that at least the cells be certified in accordance with UL1973. Battery modules and rack-mounted modules that contain UL 1973 listed cells can be assessed as part of a field evaluation as long as it can be shown that all applicable testing to UL1973 is conducted and the testing is representative of the battery modules and racks installed. **4.6.2.6 * Applicability.** The field evaluation report shall clearly identify the construction and components of the ESS covered by the field evaluation, as verified at the installation site. **A.4.6.2.6** When evaluating if a field evaluation is applicable to a given installation, the designer and AHJ should verify that the construction of the ESS at the installation site is the same as the ESS documented in the field evaluation report. This addresses the situation where, for example, a field evaluation report is based on the use of a particular manufacturer and model of battery cells, but the ESS at the installation site includes different battery cells.
Statement (technical reason for FR)	This provides an alternate method of compliance with UL 9540 without lessening safety when due to production methods or separate listing such as UL 1741, UL 1973, and separate evaluations that UL 9540 cannot be accomplish. The technical committee is seeking public comment as it is applicable to repurposed batteries that do not have a UL 1973 listing.
Response (technical reason for not making some changes or for resolving)	

2.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	CI		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	**2.2 NFPA Publications.** National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471. NFPA 790, *Standard for Competency of Third-Party Field Evaluation Bodies,* 2024 edition		
Statement (technical reason for FR)	New Section 4.6.2 requires the addition of a reference in Section 2.2.		
Response (technical reason for not making some changes or for resolving)			

A.9.2.1.1 ?	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	CI		☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	See attached word doc.		
First Revision Text (FR)	See Attached word doc.		
Statement (technical reason for FR)	**4.3.8 Technical Committee Input**. When a technical committee is considering a revision to its NFPA Standard but does not wish to include the revision in the first draft, the technical committee may submit the revision for public review and consideration as a Committee Input for the sole purpose of seeking public consideration and soliciting Public Comments. The decision to develop Committee Input shall be supported through a meeting vote requiring a simple majority and shall not be subject to ballot.		

	This annex outline is to provide a modification to 9540 and to decouple the DC block from the other listings such as inverters (UL 1741). It will provide a clearer guidance to the 9540 listings. It is outline is being coordinated with UL to help improve the listing process The technical committee is seeking public comment as it is applicable to repurposed batteries that do not have a UL 1973 listing.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
Global	372		☒ Create First Revision ☐ Resolve
Proposed Text (PI)	UL 9540 and UL 9540A are in the process of being updated via the ANSI consensus process to address proposed revisions from interested stakeholders. Consideration should be given to updating these referenced standards editions and dates if they are completed in time for inclusion in the next edition of NFPA 855. Reason: The content of the next edition of these ANSI consensus standards has not yet been finalized.		
First Revision Text (FR)	UL 9540, *Energy Storage Systems and Equipment*, 2023 ~~9540 3rd edition~~		
Statement (technical reason for FR)	Update of standard to the current 3rd edition 2023.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
2.3.7	209, 302, 264, 263	302	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. UL 263, *Fire Tests of Building Construction and Materials*, 2021. UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018. UL 1012, *Power Units Other Than Class 2*, 2021. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021. UL 1778, *Uninterruptible Power Systems*, 2017. UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications*, ~~2018~~ 2022. UL 1974, *Evaluation for Repurposing Batteries*, 2018. UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2023.		

	UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019. UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019. UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2021.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)	Standards are being updated to current editions.		
Response (technical reason for not making some changes or for resolving)			
2.3.7	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	~~264, 263~~	~~263~~	~~☒ Create First Revision~~ ~~☐ Resolve~~
Proposed Text (PI)	2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. UL 263, *Fire Tests of Building Construction and Materials*, 2021. UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018. UL 1012, *Power Units Other Than Class 2*, 2021. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021. UL 1778, *Uninterruptible Power Systems*, 2017. UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* 2018. UL 1974, *Evaluation for Repurposing Batteries*, 2018. UL 9540, *Energy Storage Systems and Equipment*, 2020. ~~UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.~~ UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019. UL 62368-1, Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements, 2021.		

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement
(technical reason for FR)</td><td colspan="3">Since this is tied to PI 263 removal of 9540A requirements then TG 4 explosion requirements.</td></tr>
<tr><td>Response
(technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">2.3.7</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>~~302~~</td><td>~~209~~</td><td>~~☒ Create First Revision~~
~~☐ Resolve~~</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">2.3.7 UL Publications.
Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.
UL 263, <i>Fire Tests of Building Construction and Materials</i>, ~~2021~~2011, revised 2022.
UL 790, <i>Standard Test Methods for Fire Tests of Roof Coverings</i>, ~~2018~~2022.
UL 1012, <i>Power Units Other Than Class 2</i>, 2010, revised 2021.
UL 1741, <i>Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources</i>, 2021, revised 2023.
UL 1778, <i>Uninterruptible Power Systems</i>, ~~2017~~2014, revised 2023.
UL 1973, <i>Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications</i>,~~ 2018~~ 2022.
CAN/UL 1974, <i>Evaluation for Repurposing Batteries</i>, 2018.
CAN/UL 9540, <i>Energy Storage Systems and Equipment</i>, ~~2020~~2021.
CAN/UL 9540A, <i>Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems</i>, 2019.
UL 60950-1, <i>Information Technology Equipment — Safety — Part 1: General Requirements</i>, 2007, revised 2019.
UL 62368-1, <i>Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements</i>, 2021.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">2.3.7 UL Publications.
Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.
UL 263, <i>Fire Tests of Building Construction and Materials</i>, ~~2021~~2011, revised 2022.
UL 790, <i>Standard Test Methods for Fire Tests of Roof Coverings</i>, ~~2018~~2022.</td></tr>
</table>

	UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021, revised 2023. UL 1778, *Uninterruptible Power Systems*, ~~2017~~2014, revised 2023. UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications*, ~~2018~~ 2022. CAN/UL 1974, *Evaluation for Repurposing Batteries*, 2018. CAN/UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2023. CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019. UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019. UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2021.		
Statement (technical reason for FR)	Standards are being updated to current editions.		
Response (technical reason for not making some changes or for resolving)			
2.3.7	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	340		☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	2.3.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. UL 263, *Fire Tests of Building Construction and Materials*, 2021. UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018. UL 1012, *Power Units Other Than Class 2*, 2021. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021. UL 1778, *Uninterruptible Power Systems*, 2017. UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications*, 2018. UL 1974, *Evaluation for Repurposing Batteries*, 2018.		

	UL 3202, Outline of Investigation for EV Charging Systems Utilizing Energy Storage, 2023 UL 9540, *Energy Storage Systems and Equipment*, 2020. UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019. UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019. UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2021.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	Note – should be tied to PI 335 - TG 5 EV Chargers Chris Towski – Not currently published, Noted to be address in PC when published
First Revision Text (FR)	

2.3.7 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 263, Fire Tests of Building Construction and Materials, ~~2021~~ 2011.

UL 790, Standard Test Methods for Fire Tests of Roof Coverings, 2018.

UL 1012, Power Units Other Than Class 2, ~~2021~~ 2010.

UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, 2021.

UL 1778, Uninterruptible Power Systems, ~~2017~~ 2014.

UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, ~~2018~~ 2022.

CAN/UL 1974, Evaluation for Repurposing Batteries, 2018.

CAN/UL 9540, Energy Storage Systems and Equipment, ~~2020~~ 2021.

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

UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.

UL 62368-1, Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements, 2021.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.4.5	89	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	4.4.5* Construction, equipment, and systems that are required for the ESS to comply with the hazard mitigation analysis shall be installed, tested, and maintained in accordance with this standard, product listings and the manufacturer's instructions.		
First Revision Text (FR)	4.4.5* Construction, equipment, and systems that are required for the ESS to comply with the hazard mitigation analysis shall be installed, tested, and maintained in accordance with this standard and the manufacturer's instructions.		
Statement (technical reason for FR)	The manufacture instructions are cover by the product listing.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
A.4.6.9.1	111	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	A.4.6.9.1 UL 9540 requires inverters, chargers, and charge control equipment that are part of an ESS to be designed and rated for use with the battery system employed in the ESS and evaluated to UL 1741, UL 62109-1, CAN/CSA C22.2 No. 62109-1, UL 1012, ~~UL 1778,~~ UL 62368-1, CAN/CSA C22.2 No 62368, UL 1778, or CAN/CSA C22.2 No. 107.1 as applicable to the power conversion equipment and its application in the system. UL 9540 also requires power conditioning systems for standalone and multi-mode applications to comply with UL 1741, UL 62109-1, CAN/CSA C22.2 No. 62109-1, or CSA C22.2 No. 107.1.		

First Revision Text (FR)	A.4.6.9.1 UL 9540 requires inverters, chargers, and charge control equipment that are part of an ESS to be designed and rated for use with the battery system employed in the ESS and evaluated to UL 1741, UL 62109-1, CAN/CSA C22.2 No. 62109-1, UL 1012, UL 62368-1, CAN/CSA C22.2 No 62368, UL 1778, or CAN/CSA C22.2 No. 107.1 as applicable to the power conversion equipment and its application in the system. UL 9540 also requires power conditioning systems for standalone and multi-mode applications to comply with UL 1741, UL 62109-1, CAN/CSA C22.2 No. 62109-1, or CSA C22.2 No. 107.1.
Statement (technical reason for FR)	This adds standards that are relevant to charging side of the BESS systems that ultimately are part of the UL 9540 listing.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
3.3.8	101	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	3.3.8* Energy Storage Management System (ESMS). A system that monitors, controls, and optimizes the performance and/or safety of an energy storage system.		
First Revision Text (FR)	A.3.3.8 Energy Storage Management System (ESMS). Some standards refer to this as an energy management system (EMS). This system can control or send signals to one or more individual management systems, such as battery management systems (BMS), fire alarm control units (FACU), building automation systems (BAS), and possibly other site systems. Generally, these signals cause the BMS, FACU, and BAS to operate controls, such as battery charging disconnect, fire control protocols, and ventilation shutdown or activation.		
Statement (technical reason for FR)	What the ESMS can do itself to "control" safety is limited, so other site systems must be leveraged to minimize risk. Therefore, the safety portion of this definition was further elaborated on in annex material so as not to confuse which parts of the beginning of the sentence apply to performance, and which apply to safety.		
Response (technical reason for not making some changes or for resolving)	And/or is not allowed by the NFPA Manual of Style. There are two options to properly resolve this. One would be to make two separate sentences in the definition (one for what the ESMS can do for performance, and the other for what it can do for safety). Because what it can do for safety involves a more complex interaction with more explanation, this material better-belonged in an annex since the ESMS is actually not doing the "controlling" for safety.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New A.3.3.9.4	260	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	A.3.3.9.4 In applying this definition the concept of "walk-in access" means the ability or need for any portion of the body to enter the space other than the arms. In crafting the technical language and definition the committee relied on a review of the definition of entry for confined spaces found at Code of Federal Regulations 1910.146.(b) "Entry means the action by which a person passes through an opening into a permit-required confined space". Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space. Though the confined space definition is if any part of the body crosses the plane, the committee determined that reaching in to service equipment		

	was acceptable. Its important to note that many of these structures and containers would be considered confined spaces.
First Revision Text (FR)	3.3.9.4* Energy Storage System Walk-In Unit. An enclosure ~~structure~~ or container~~ing~~ of an energy storage system~~s that includes~~ equipped with a means (such as a door~~s~~) ~~that provide~~ to allow personnel to enter and walk~~-in~~ through~~access for personnel to maintain, test, and service the equipment and is typically used in outdoor and mobile energy storage system applications~~. A.3.3.9.4 Some of these enclosures and containers may be considered confined spaces. These are typically used in outdoor and mobile energy storage system applications.
Statement (technical reason for FR)	It is important to clarify what “walk-in” means by talking about entry and walking through. It is not necessary to include tasks that may or may not be done in a walk-in unit on a site visit (since it is still a walk-in unit even if no maintenance, service, or testing is occurring), so that portion of the existing definition was removed. The explanatory material about the majority of these types of units being outdoors or mobile has nothing to do with the definition, but is helpful. A new annex note was created with that portion of the definition moved to the annex.
Response (technical reason for not making some changes or for resolving)	Most of the proposed annex material covered historical derivation (including its “basis” in OSHA confined space rules found in 29CFR Part 1910) of the existing definition, which is not necessary for the user to know. References to 29CFR Part 1910 (where the existing definition was historically derived from) did not add to the usefulness to the user. Modifying the existing definition to clearly state “entry” and “walking through” was a much more succinct way to handle than the lengthy suggestion.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
3.3.16	283	~~None~~344	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	3.3.16 Maximum Stored Energy. The quantity of energy storage permitted in a fire area ~~prior to the area being considered a high hazard occupancy~~ without additional analysis, testing and AHJ approval.		
First Revision Text (FR)	3.3.16* Maximum Stored Energy.		

	The quantity of rated energy storage permitted in a fire area ~~prior to the area being considered a high hazard occupancy~~without additional analysis, testing, and AHJ approval. A.3.3.16 This is a sum of the rated (per the listing) energies of all of the energy storage systems in a given fire area.
Statement (technical reason for FR)	Nothing in the standard besides the definition indicates energy storage above the maximum stored energy (formerly MAQ) is considered a high hazard occupancy. The revised definition is more aligned with the maximum stored energy section of 9.4.1. Annex material was added to clarify that the “maximum” in a fire area includes a summation of all energy storage systems in that area. The rated energy from the listing was added to define “maximum” stored energy, similar to what is done in the footnotes of Tables 1.3, and 9.4.1 to properly define kWh.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
3.3.20	57	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	3.3.20 Qualified Person. One who has skills, ~~and~~ knowledge, training, and experience, related to the construction and operation of ~~the electrical equipment and~~ energy storage systems installations and has received safety training to recognize and ~~avoid~~ mitigate the hazards involved. [**70:**100]		
First Revision Text (FR)	Current 855 definition is NEC 2023 edition extraction. 3.3.20 Qualified Person. One who has skills, ~~and~~ knowledge and training related to the construction and operation of ~~the~~energy storage systems and electrical equipment and installations and has received safety training to recognize, ~~and~~ avoid and mitigate the hazards involved. ~~[70, :1002023]~~		
Statement (technical reason for FR)	The existing NFPA 70 definition is not specific to energy storage (for example, it doesn’t include non-electrical hazards found in ESS). The NFPA 70 definition also differs from OSHA [29CFR Part 1926.32(m)], NFPA 70E and NFPA 70B definitions. All of these definitions were considered to formulate the optimal verbiage. The extract reference was removed because the definition was changed from what is in NFPA 70.		

Response (technical reason for not making some changes or for resolving)	.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	344	~~None~~283	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	Stored Energy. Maximum stored energy for Energy storage systems is defined as its maximum rating per the listing.		
First Revision Text (FR)	3.3.25 Stored Energy. The amount of energy stored in the ESS at a given point in time, which can vary depending on state-of-charge (SOC) or similar metrics for non-battery technologies.		
Statement (technical reason for FR)	The term “stored energy” is found in many places across the standard, but is not defined.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New Definition	176	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	Thermal Walkaway Thermal walkaway is a slow heating process driven by an external current source and caused by abuse, neglect or internal cell failure that results in overheating and increased gas production in a lead-acid or nickel-cadmium (or other aqueous chemistry) battery. It can be stopped by removal of the charging source or reduction of the charging current.		
First Revision Text (FR)	3.3.28 Thermal Walkaway A slow heating process driven by an external current source and caused by abuse, neglect or internal cell failure that results in overheating and increased gas production in a lead-acid or nickel-cadmium (or other aqueous chemistry) battery which can be controlled by removal of the charging source or reduction of the charging current.		

Statement (technical reason for FR)	There is a need to differentiate between the rapidly progressing thermal runaway that occurs in Li-ion batteries, and which can occur without an external current source; and the much slower process of thermal walkaway that occurs in aqueous batteries, which can be detected early with proper monitoring/maintenance and can be stopped by control or removal of charging current.
Response (technical reason for not making some changes or for resolving)	Sentences were combined for improved readability.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.6.12.2	291	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	**4.6.12.2** ESS electrical circuitry shall be within ~~weatherproof~~ enclosures marked with the environmental rating suitable for the type of exposure required by *NFPA 70*.		
First Revision Text (FR)	4.6.12.2 * ~~ESS electrical circuitry shall be within weatherproof e~~Enclosures shall be marked with an enclosure-type number suitable for the environmental ~~rating suitable for the type of exposure~~conditions required by ~~NFPA 70~~applicable codes and standards. A.4.6.12.2 Applicable codes and standards covering electrical enclosure types may include NFPA 70, NEMA 250, and ANSI/IEC 60529		
Statement (technical reason for FR)	Indoor enclosures in controlled environments don't need to be weatherproof. It is sufficient to say enclosures are suitable for the type of exposure required by applicable codes and standards. The first part of the sentence was unnecessary, and there are non-electrical components in energy storage systems. NFPA 70 is not the only document specifying suitable enclosure types, especially outside of North America, and thus the reference was made more generic to applicable codes and standards, with examples in the annex.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.2	256	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.7.2 Seismic Protection. ESS shall ~~be seismically braced~~ meet seismic requirements in accordance with the local building code.		
First Revision Text (FR)	4.7.2 Seismic Protection. ESS shall ~~be seismically braced~~meet seismic requirements in accordance with the ~~local~~ applicable building codes.		

Statement (technical reason for FR)	This makes the compliance with the seismic requirements more general rather than specifying bracing.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.4.3.1	138	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.7.4.3.1 Energy storage located on property that is under the exclusive control of electric utilities, secured from public access, and in accordance with 90.2(D)(5) of *NFPA 70* shall not be required to comply with 4.7.4.3.		
First Revision Text (FR)	4.7.4.3.1 Energy storage located on property that is under the exclusive control of electric utilities, secured from public access, and in accordance with 90.2(D)(5) of NFPA 70 shall not be required to comply with 4.7.4.3.		
Statement (technical reason for FR)	The section qualifies that the specific NEC 90.2(D)(5) exclusion refers to electric utilities not just any type of utility.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
4.7.7.1.2	294	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	4.7.~~7.~~1~~.2~~ The ESS shall not be located inside an electrical room. 4.7.~~7.1.3~~2 The ESS shall be accessible to emergency responders without traversing through an electrical room.		

First Revision Text (FR)	4.7.1 When an ESS is installed in a structure, it shall be installed in a dedicated location such that emergency responders can readily access the ESS. ~~4.7.7.1.2~~ ~~The ESS shall not be located inside an electrical room.~~ ~~4.7.7.1.3~~ ~~The ESS shall be accessible to emergency responders without traversing through an electrical room.~~
Statement (technical reason for FR)	Current requirements only provide location guidance for installations below grade, but it is important that safe access to the installation for emergency responders be available in all locations. New language was inserted at the beginning of Section 4.7 (Installation), so that it is generally applicable.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
7.2.5.2	297	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	7.2.5.2 After recommissioning the system, training on any changes to the operation and maintenance procedures or documentation shall be provided.		
First Revision Text (FR)	7.2.5.2 After recommissioning ~~the system~~an ESS, training on any changes to the procedures and documentation related to the operation and maintenance ~~documentation~~ of the system shall be provided to the system owner and operators. 7.2.5.3 Updated information shall also be transmitted to emergency responders if the recommissioned system presents a change in the hazard.		
Statement (technical reason for FR)	Training should cover both procedures and documentation that have been changed as part of a recommissioning. The new requirement ensures first responders are also trained (not just owner/operators).		

Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.2.3.1	301	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.2.3.1* Where required by the equipment listing in accordance with 4.6.1 or the hazard mitigation analysis in accordance with Section 4.4, an approved ESMS or BMS shall be provided for monitoring operating conditions and maintaining voltages, currents, and temperatures within the manufacturer's specifications~~, unless modified in accordance with Chapters 9 through 13~~.		
First Revision Text (FR)	9.2.3.1* Where required by the equipment listing in accordance with 4.6.1 or the hazard mitigation analysis in accordance with Section 4.4, an approved ESMS or BMS shall be provided for monitoring operating conditions and maintaining voltages, currents, and temperatures within the manufacturer's specifications~~, unless modified in accordance with Chapters 9 through 13~~.		
Statement (technical reason for FR)	There is nothing in Chapters 9-13 presently that would invalidate the need for an ESMS or BMS if the listing of the particular product or HMA requires it. Therefore, the ending clause is unnecessary.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.2.3.2	Carry over from PI 27	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.2.3.2* The ESMS or BMS shall electrically isolate the ESS or affected components of the ESS ~~or place the system in a safe condition~~ if potentially hazardous conditions are detected.		
First Revision Text (FR)	9.2.3.2*		

	The ESMS or BMS shall electrically isolate the ESS or affected components of the ESS ~~or place the system in a safe condition~~ if potentially hazardous conditions are detected.
Statement (technical reason for FR)	What the ESMS can do itself to “control” safety is limited, so other site systems must be leveraged to minimize risk.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.2.1	308	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	~~9.5.2.1 HMA.~~ ~~A HMA shall be required for lithium-ion ESS that exceed 600 kWh (2,160 MJ) for outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment.~~		
First Revision Text (FR)	~~9.5.2.1 HMA.~~ ~~A HMA shall be required for lithium-ion ESS that exceed 600 kWh (2,160 MJ) for outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment.~~		
Statement (technical reason for FR)	The requirement is already in 9.4.1.2. There is no need to repeat it.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.5.3.2 and New 9.5.3.2.2	365	Carry over from PI 27	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.5.3.2 Mobile ESS Equipment and Operations. Mobile ESS operation shall be classified as specified in 9.5.3.2.~~1~~2 or 9.5.3.2.3.		

<table>
<tr><td></td><td colspan="3">I have not included subsections not being changed.
9.5.3.2.2 The requirements of this section do not apply to ESS that are 100kWh or less when permanently mounted on a vehicle or trailer to power electrical systems installed on the vehicle or trailer when the ESS is listed in accordance with 4.6.1.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.5.3.2 Mobile ESS Equipment and Operations.
~~Mobile ESS operation shall be classified as specified in 9.5.3.2.1 or 9.5.3.2.2~~</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">Section 9.5.3.2 is incorrectly referencing the subsections. Removing the references to the subsections makes it read better.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">While the idea of trying to exclude things like solar and battery powered loncheras from being covered as a "mobile ESS", the scope of NFPA 855 already excludes them since they don't usually connect to the grid and are not generally going to be parked for months and years. Also, there was no justification provided for the 100 kWh break point.</td></tr>
<tr><td></td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td></td><td>Carry over from PI 27</td><td>365</td><td>☒ Create First Revision
☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.5.3.2.1.2
Mobile ESS used to temporarily provide power to lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 9.5.3.2.1.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">~~9.5.3.2.1.2~~
~~Mobile ESS used to temporarily provide power to lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 9.5.3.2.1.~~</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">This text is an exact duplicate of 9.5.3.2.2.2. Since 9.5.3.2.1 talks about storage of mobile ESS and 9.5.3.2.2 is for deployment, the actual usage of the mobile ESS is only in 9.5.3.2.2, and thus this statement does not need to also be in 9.5.3.2.1.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td></td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
</table>

	Carry over from PI 27	365	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.5.3.2.2.2 Mobile ESS used to temporarily provide power to lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 9.5.3.2.2.		
First Revision Text (FR)	9.5.3.2.2.2 Mobile ESS used to temporarily provide power to lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 9.5.3.2.2.		
Statement (technical reason for FR)	The NFPA Manual of Style discourages absolute statements about safety, and removing the word here does not change the meaning of the sentence.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
A.9.6.5.1	38	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.9.6.5.1 This section addresses hazards associated with the release of flammable gases from ESS during normal charging, discharging, and use conditions. Similar requirements have been in fire codes for many years primarily to address off-gassing of hydrogen from stationary vented lead-acid battery systems but not limited to that technology. This section is not intended to provide protection against the release of flammable gases during abnormal charging or thermal runaway conditions. Those conditions are addressed in 9.6.5.6. In addition, this section does not regulate ventilation of toxic and highly toxic ~~gases~~emissions, which are regulated by 4.6.11.		
First Revision Text (FR)	A.9.6.5.1 This section addresses hazards associated with the release of flammable gases from ESS during normal charging, discharging, and use conditions. Similar requirements have been in fire codes for many years primarily to address off-gassing of hydrogen from stationary vented lead-acid battery systems but not limited to that technology.		

	This section is not intended to provide protection against the release of flammable gases during abnormal charging or thermal runaway conditions. Those conditions are addressed in 9.6.5.6. In addition, this section does not regulate ventilation of toxic and highly toxic ~~gases~~emissions, which are regulated by 4.6.11.
Statement (technical reason for FR)	Toxic emissions can include more than gasses.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.2	96, 97 (same revision)	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.2* Spill Control. A.9.6.5.2 Spill control may be provided as part of the listed product or as part of the site installation. If spill control is not provided as part of a listed product, then the manufacturer's manual provides guidance for the installation.		
First Revision Text (FR)	9.6.5.2*_ Spill Control. A.9.6.5.2 Spill control may be provided as part of the listed product or as part of the site installation. If spill control is not provided as part of a listed product, then the manufacturer's manual provides guidance for the installation.		
Statement (technical reason for FR)	UL 9540 has provisions for secondary containment to be supplied at installation as long as this is included in the instruction manual. Section 9.6.5.2 currently implies that additional containment may be necessary even if it is supplied with the product under the scope of its listing. This change clarifies when additional containment should be provided.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.2.1	177	None	☒~~☐~~ Create First Revision ☐ Resolve

Proposed Text (PI)	9.6.5.2.1 Rooms~~, buildings~~ or areas containing ESS with free-flowing liquid electrolyte in individual vessels having a capacity of more than 55 gal (208 L) or multiple vessels having an aggregate capacity exceeding 1000 gal (3785 L) shall be provided with spill control to prevent the flow of liquids to adjoining areas.
First Revision Text (FR)	9.6.5.2.1 Rooms~~, buildings,~~ or areas containing ESS with free-flowing liquid electrolyte in individual vessels having a capacity of more than 55 gal (208 L) or multiple vessels having an aggregate capacity exceeding 1000 gal (3785 L) shall be provided with spill control to prevent the flow of liquids to adjoining areas.
Statement (technical reason for FR)	It is best to contain only the area with the batteries so that spills do not spread into non-battery areas. This change clarifies that generally you would not put containment for the entire building.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
A.9.6.5.3.1	98	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.9.6.5.3.1 One method to determine compliance with the neutralization requirements of this subsection is found in UL Subject 2436. UL Subject 2436 investigates the liquid tightness, level of electrolyte absorption, pH neutralization capability, and flame spread resistance of spill containment systems. Where approved methods are specified for removal of spilled electrolyte, the neutralization can occur after removal from site. It may be safer to remove spilled electrolyte from site then neutralize it in a controlled environment.		
First Revision Text (FR)	A.9.6.5.3.1 One method to determine compliance with the neutralization requirements of this subsection is found in UL Subject 2436. UL Subject 2436 investigates the liquid tightness, level of electrolyte absorption, pH neutralization capability, and flame spread resistance of spill containment systems. Where approved methods are specified for removal of spilled electrolyte, the neutralization can occur after removal from site. It may be safer to remove spilled electrolyte from site then neutralize it in a controlled environment.		

Statement (technical reason for FR)	For large spills of acidic or caustic electrolytes, whether of traditional batteries, or flow batteries, indoor neutralization can produce toxic gasses and possibly acidic or caustic mist. Therefore, neutralization may be best left until the absorbed spill products have been moved to a better ventilated area, such as outdoors. This change allows for that to happen rather than requiring indoor neutralization of all spills.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.4	293	None	☐ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.4* Safety Caps. Where required by Table 9.6.5, vented batteries used in ESS shall be provided with flame-arresting safety caps. Flame-arresting safety caps shall not be required if flame-arresting is achieved through other design mechanisms. Alternative flame-arresting methods to safety caps shall be reviewed and approved by a third-party FPE.		
First Revision Text (FR)	9.6.5.4* Safety Caps. Where required by Table 9.6.5, vented batteries used in ESS shall be provided with flame-arresting safety caps or another technology reviewed and approved by the AHJ. A.9.6.5.4 If recombination caps are used they should contain evaluated flame arresters. For flame arresting technologies not yet covered by existing standards, if the AHJ wishes, they could request a report on the technology prepared by a qualified expert.		
Statement (technical reason for FR)	For newer technologies, existing flame arrestors and current UL standards may not drive the best choice of flame-arresting technology.		
Response (technical reason for not making some changes or for resolving)	The suggested language suggested was too open, and only an AHJ can provide approval, not an FPE.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
9.6.5.5	Carry over from PI 27	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	9.6.5.5* Thermal Runaway Protection. Where required by Table 9.6.5, a listed device evaluated as part of the ESS or other approved method shall be provided to manage charging and discharging during normal operation of the ESS to maintain batteries and capacitors within their ~~safe~~ operating parameters and preclude thermal runaway.		
First Revision Text (FR)	9.6.5.5* Thermal Runaway Protection. Where required by Table 9.6.5, a listed device evaluated as part of the ESS or other approved method shall be provided to manage charging and discharging during normal operation of the ESS to maintain batteries and capacitors within their ~~safe~~ operating parameters and preclude thermal runaway.		
Statement (technical reason for FR)	The NFPA Manual of Style discourages absolute statements about safety, and removing the word here does not change the meaning of the sentence.		
Response (technical reason for not making some changes or for resolving)			
A.9.6.5.5	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	174	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	A.9.6.5.5 A component of the thermal runaway protection might be integrated within the ESS battery management system or ESS management system that controls the charging and discharging to keep the ESS within its normal/safe operating limits when that device has been evaluated with the batteries or capacitors as part of the listing to UL 1973 or UL 9540, as applicable. The device might also initiate appropriate hazard mitigation as required elsewhere in this standard when the ESS is in an abnormal state such as overheating or off-gassing. VRLA battery systems, if abused or neglected for long periods of time, may go into thermal walkaway. This condition is not to be confused with thermal runaway as seen in lithium-ion batteries. Much less heat and combustible gas is produced and is well known. Calculations for hydrgen gassing of lead-acid and nickel-cadmium batteries under thermal walk away conditions are found in IEEE 1635/ASHRAE 21. This is referenced in UL 1973. Thermal walkaway in VRLA batteries is typically prevented by use of temperature compensated charging. Even though a VRLA may occassionally go into thermal walkaway, no flame is produced. Melting of the jar container may occur, but no fire is instigated for VRLA batteries listed to UL 1973.		

First Revision Text (FR)	A.9.6.5.5 A component of the thermal runaway protection might be integrated within the ESS battery management system or ESS management system that controls the charging and discharging to keep the ESS within its normal/safe operating limits when that device has been evaluated with the batteries or capacitors as part of the listing to UL 1973 or UL 9540, as applicable. The device might also initiate appropriate hazard mitigation as required elsewhere in this standard when the ESS is in an abnormal state such as overheating or off-gassing. VRLA battery systems, if abused or neglected for long periods of time, may go into thermal walkaway. This condition is not to be confused with thermal runaway as seen in lithium-ion batteries. Much less heat and combustible gas is produced and is well known. Calculations for hydrogen gassing of lead-acid and nickel-cadmium batteries under thermal walk away conditions are found in IEEE 1635/ASHRAE 21. This is referenced in UL 1973. Thermal walkaway in VRLA batteries is typically prevented by use of temperature compensated charging. Even though a VRLA may occasionally go into thermal walkaway, no flame is produced. Melting of the jar container may occur, but no fire is instigated for VRLA batteries listed to UL 1973.
Statement (technical reason for FR)	There is a need to clarify misconceptions regarding aqueous battery thermal "runaway" Thermal walkaway can occur in aqueous batteries, but happens in most cases because of abuse or neglect and takes months/years to develop. It is easily controlled with temperature compensation charging and/or recommended maintenance. In contrast, thermal runaway is usually a very fast occurring process with limited or no warning and cannot be prevented at least at the individual cell level. The quantities of heat and combustible gasses produced by a lithium-ion thermal runaway event are orders of magnitude greater than those produced by an aqueous battery thermal walkaway.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
11.1.1	213	None	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	11.1.1 Stationary fuel cell ESS shall comply with the following requirements of Chapter 4 and Chapter 9: (1) Charge controllers *(see 4.6.8)* (2) Inverters and converters *(see 4.6.9)* (3) Energy storage management system (ESMS) *(see 4.6.10)* (4) Impact protection *(see 4.7.5)* (5) Smoke and fire detection *(see Section 4.8)* (6) Fire control and suppression *(see Section 4.9)* (7) Water supply *(see 4.9.4)*		

	(8) Signage *(see 4.7.4)* (9) Combustible storage *(see Section 4.5)* (10) Hazard mitigation analysis *(see Section 4.4)* (11) Emergency planning and training *(see Section 4.3)* (12) Construction documents *(see Section 4.2)* (13) Spill Control (see Section 9.6.5.2)
First Revision Text (FR)	11.1.1 Stationary fuel cell ESS shall comply with the following ~~requirements of Chapter 4~~: 1. Charge controllers *(see 4.6.8)* 2. Inverters and converters *(see 4.6.9)* 3. Energy storage management system (ESMS) *(see 4.6.10)* 4. Impact protection *(see 4.7.5)* 5. Smoke and fire detection *(see Section 4.8)* 6. Fire control and suppression *(see Section 4.9)* 7. Water supply *(see 4.9.4)* 8. Signage *(see 4.7.4)* 9. Combustible storage *(see Section 4.5)* 10. Hazard mitigation analysis *(see Section 4.4)* 11. Emergency planning and training *(see Section 4.3)* 12. Construction documents *(see Section 4.2)* ~~12.~~13. *Spill Control for Liquid Fuels (see Section 9.6.5.2)*
Statement (technical reason for FR)	Some fuel cells have a liquid fuel source (e.g., methanol), and thus would need spill containment where minimum quantities found in Chapter 9 are exceeded.
Response (technical reason for not making some changes or for resolving)	The sections are called out in the list items, and thus there is no need to reference the chapters in the header.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.1.1.1	194	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	6.1.1.1 Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 battery requirements shall be permitted to have a commissioning plan complying with recognized industry practices in lieu of complying with 6.1.5.2.		
First Revision Text (FR)	6.1.1.1 Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76 battery requirements shall be permitted to have a commissioning plan complying with recognized industry practices in lieu of complying with 6.1.5.2.		
Statement (technical reason for FR)	Many of the NFPA 76 requirements apply to telecom equipment and spaces unrelated to the safety or operation of the battery plant. When referencing NFPA 76 compliance in this section, it is reasonable to delineate that conformance to the battery requirements is the area of concern.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.1.3.2	102	91	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	6.1.3.2 The commissioning plan shall include, but not be limited to, the following information: (1) An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted (2) Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s) (3) Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s)		

	(4) Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems (5) A detailed description of each activity to be conducted during the commissioning process, who will perform each activity, and at what point in time the activity is to be conducted (6) Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems (7) Testing for any required fire detection or suppression and thermal management, ventilation, or exhaust systems associated with the installation and verification of proper operation of the safety controls (8) The following documentation: (a) Commissioning checklist (b) Relevant operational testing forms (c) Necessary commissioning logs (d) Progress reports (9) Means and methods whereby facility operation and maintenance staff will be trained on the system (10) Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system ~~(11) A decommissioning plan meeting the provisions of Section 8.1 that covers the removal of the system from service and from the facility in which it is located and information on disposal of materials associated with each ESS~~
First Revision Text (FR)	
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	A vendor specified decommissioning plan is critical information for the system owner. Having this prepared at the time of commissioning protects against instances where manufacturer of the system exits the business or otherwise can no longer provide information on safe decommissioning at some future date. Having a decommissioning plan formulated at the time of commissioning does not prevent it from being later revised or updated by the owner or designated agent and submitted for AHJ approval as noted in Chapter 8. The text in Section 8.1 is correct as written and need not change.

6.1.3.2	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	91, 92 (annex)	102	☒ Create First Revision ☐ Resolve
Proposed Text (PI)			

First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	Revised to add testing of spill detection systems. It is important that spill detection systems be tested for proper operation as they help assure safe operation of certain types of ESS. The added annex information provides a useful list of procedures to be validated and includes a cross reference to the location in chapter 7 for these procedures which is useful to the reader. NOTE However: Nothing in the 2023 editions requires spill detection. Maybe the Flow Battery Task Group TG20 is suggesting adding this to the first draft.
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	6.1.3.2* The commissioning plan shall include, but not be limited to, the following information: 1. An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted 2. Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s) 3. Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s) 4. Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems 5. A detailed description of each activity to be conducted during the commissioning process, who will perform each activity, and at what point in time the activity is to be conducted 6. Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems 7. Testing for any required fire detection or suppression, spill detection, ~~and~~ thermal management, ventilation, or exhaust systems associated with the installation and verification of proper operation of the safety controls 8. The following documentation: a. Commissioning checklist b. Relevant operational testing forms c. Necessary commissioning logs

	d. Progress reports 9. Means and methods whereby facility operation and maintenance staff will be trained on the system 10. Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system 11. A decommissioning plan meeting the provisions of Section 8.1 that covers the removal of the system from service and from the facility in which it is located and information on disposal of materials associated with each ESS. A.6.1.3.2 Examples of the procedures to be used in documentation of the proper operation of the ESS and all associated operational controls and safety systems include the following: 1. ESS input and output power should track the commands 2. ESS shuts down when shut-down command is sent. Procedures for safe start up and shut down as described in 7.1.2(1) and procedures for inspection and testing of associated alarms, interlocks, and controls as described in 7.1.2(2) should be made available at the start of commissioning.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.1.4.2	296	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	6.1.4.2 System testing shall ~~be conducted as a component of the commissioning process and include functional performance testing of the ESS that demonstrates~~ demonstrate that the installation and operation of the system and associated components, controls, and safety-related systems are in accordance with approved plans and specifications and ~~that~~ confirm the operation, function, and maintenance serviceability ~~for each~~ of the ~~commissioned~~ ESS ~~is confirmed~~.		
First Revision Text (FR)	6.1.4.2 System testing shall ~~be conducted as a component of the commissioning process and include functional performance testing of the ESS that demonstrates~~demonstrate that the installation and operation of the system and associated components, controls, and safety-related systems are in accordance with approved plans and specifications and ~~that~~ confirm the operation, function, and maintenance serviceability ~~for each~~ of the ~~commissioned~~ ESS ~~is confirmed~~.		

Statement (technical reason for FR)	Edited to clarify the requirement.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
6.3.1	251	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	6.3.1 ~~Operations~~ The ESS owner shall maintain operations and maintenance documentation ~~shall be provided to the ESS owner~~.		
First Revision Text (FR)	6.3.1 Operations and maintenance documentation shall be provided to the ESS owner at time of installation, and owner is responsible to ensure that all operations and maintenance documentation is maintained for the entire length of system operation.		
Statement (technical reason for FR)	The revision clarifies that the ESS owner is responsible for the operations and maintenance records. Although the ESS owner can hire contractors to perform the operations and maintenance and to prepare and submit maintenance logs, ultimately, the ESS owner is responsible for them. Over the course of the system lifetime, it is possible that different contractors will be hired to perform maintenance and the ESS owner will need to make sure that all of the records are maintained.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
A.6.4.2	254	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	A.6.4.2 Listed software changes completed as part of providing new operating modes or functions should be considered system renewals ~~because it is a listed change~~.		

First Revision Text (FR)	A.6.4.2 Listed software changes not intended to provide new operating modes or functions should be considered like-for-like repairs. ~~system renewals because it is a listed change.~~ Listed software changes completed as part of providing new operating modes or functions should be considered system renewals.
Statement (technical reason for FR)	It is important that significant software changes that alter the operating modes or functions be properly reviewed for approval and initiate a recommissioning qualification like other system renewals. Note to TC: NFPA 855 uses Repair, Retrofit, Renewal, Renovation, Replacement… these should perhaps be better defined and checked for consistent usage.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
8.1.2	26	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	8.1.2* Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ orderly shutdown of generating stations under the exclusive control of the electric utilities and located outdoors or in building spaces used exclusively for such installations shall be permitted to have a decommissioning plan complying with applicable governmental laws and regulations in lieu of complying with 8.1.3.		
First Revision Text (FR)	8.1.2* Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or ~~safe~~ orderly shutdown of generating stations under the exclusive control of the electric utilities and located outdoors or in building spaces used exclusively for such installations shall be permitted to have a decommissioning plan complying with applicable governmental laws and regulations in lieu of complying with 8.1.3.		
Statement (technical reason for FR)	The use of “safe” is discouraged by NFPA Manual of Style. Orderly is a sufficient description.		
Response (technical reason for not making some			

changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
8.1.3	298	None	☒ Create First Revision ☐ Resolve
Proposed Text (PI)	8.1.3* The decommissioning plan shall be provided to the AHJ and include the following information: (1) An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned (2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site (3) ~~Means and methods in~~ The original version of the decommissioning plan submitted during the permitting process ~~to be made available at a point in time corresponding to the decision to decommission the ESS~~ (4) Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained (5) A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time (6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned (7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports (8) A description of how any changes to the surrounding areas and other systems adjacent to the ESS, including, but not limited to, structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed		
First Revision Text (FR)	8.1.3* The decommissioning plan shall be provided to the AHJ and include the following information: 1. An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned 2. Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site 3. ~~Means and methods in the~~The version of the decommissioning plan submitted during the permitting process ~~to be made available at a point in time corresponding to the decision to decommission the ESS~~ 4. Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained		

	5. A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time 6. Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned 7. Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports 8. A description of how any changes to the surrounding areas and other systems adjacent to the ESS, including, but not limited to, structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed
Statement (technical reason for FR)	The edit simplifies the wording while emphasizing the need to provide a copy of the original decommissioning plan created at the start of the project.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
2.3.2	133	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. ASTM E108, *Standard Test Methods for Fire Tests of Roof Coverings*, 2020a. ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, ~~2020~~2022.		
First Revision Text (FR)	2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. ASTM E108, Standard Test Methods for Fire Tests of Roof Coverings, 2020a. ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials, ~~2020~~ 2022.		
Statement (technical reason for FR)	This updates the publication to the current date of publication.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
C.3	269	330	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	C.3 Suppression Systems. Some ESS design validations have included pre-engineered inert or clean agent fire suppression systems for fire protection. These system installations were often approved without validation based on fire and explosion testing in accordance with 9.1.5 by nationally recognized testing laboratories. Such systems are often validated with large extrapolation factor as experimental tests have been done in a small scale using only single or few lithium-ion cells as a fire load. Evidence-based data is needed to ensure ESS designers specify appropriate fire protection systems based on the material involved and physical design characteristics. Several early research papers from multiple organizations, including NFPA's Fire Protection Research Foundation, and third-party engineering groups have shown that fires involving lithium-ion cells		

<table>
<tr><td></td><td colspan="3">must be cooled to terminate the thermal runaway process. Water is the agent of choice, yet system cabinet design could pose a significant barrier to the efficient application of water while simultaneously allowing the free movement of fire and combustion gases.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">C.3 Suppression Systems.

Some ESS design validations have included pre-engineered inert or clean agent fire suppression systems for fire protection. These system installations were often approved without validation based on fire and explosion testing in accordance with 9.1.5 by nationally recognized testing laboratories. Such systems are often validated with a large extrapolation factor as experimental tests have been done on a small scale using only single or few lithium-ion cells as a fire load. Evidence-based data is needed to ensure ESS designers specify appropriate fire protection systems based on the material involved and physical design characteristics. Several early research papers from multiple organizations, including NFPA’s Fire Protection Research Foundation, and third-party engineering groups have shown that fires involving lithium-ion cells must be cooled to terminate the thermal runaway process. Water is the agent of choice, yet system cabinet design could pose a significant barrier to the efficient application of water while simultaneously allowing the free movement of fire and combustion gases.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">There is open disagreement upon whether clean agents or an encapsulating agent combined with water are acceptable to use to fight Lithium fires. The added sentence acknowledges that while certain testing has been done, results using extrapolation factors along with the lack of system level testing is insufficient. Thus, the added sentence supports the rest of the text that additional evidence based data is needed.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">C.3</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>330</td><td>269</td><td>☐ Create First Revision
☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">C.3 Suppression Systems.

Some ESS design validations have included pre-engineered inert or clean agent fire suppression systems for fire protection. These system installations were often approved without validation based on fire and explosion testing in accordance with 9.1.5 by nationally recognized testing laboratories. Evidence-based data is needed to ensure ESS designers specify appropriate fire protection systems based on the material involved and physical design characteristics. Several early research papers from multiple organizations, including NFPA’s Fire Protection Research Foundation, and third-party engineering groups have shown that fires involving lithium-ion cells must be cooled to terminate the thermal runaway process. Water ~~is the agent~~ or water with an additive, encapsulting agent (EA), are the agents of choice, yet system cabinet design could pose a significant barrier to the efficient application of water while simultaneously allowing the free movement of fire and combustion gases.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3"></td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3"></td></tr>
</table>

Response (technical reason for not making some changes or for resolving)	There is no evidence to support the statement that water with an encapsulating agent is an agent of choice.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
C.4.2	49	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	C.4.2 Fires. Fires in electrochemical ESS are often a result of a process called *thermal runaway.* Thermal runaway can simply be defined as the process in which a battery creates heat but cannot dissipate that heat, resulting in dynamic temperature increase. Initial signs of thermal runaway might include pressure increase at the cell level, temperature increase, and off-gassing. As the process continues, additional signs might include vent gas ignition, exploding cells, projectile release, heat propagation, and flame propagation. As the failure cascades, responders should also be prepared for toxic and highly toxic emissions and potentially explosive gas release. Though fire and explosion testing in accordance with 9.5.3.2 to determine battery burn outcomes, including toxic gas release calculations, remains incomplete, responders should treat them as highly dangerous and use their full suite of PPE and breathing apparatus when responding. Proper response to electrochemical ESS fires should include the following procedures and steps: (1) System isolation and shutdown (2) Hazard confinement and exposure protection (3) Fire suppression (4) Ventilation		
First Revision Text (FR)	C.4.2 Fires. Fires in electrochemical ESS are often a result of a process called *thermal runaway.* Thermal runaway can simply be defined as the process in which a battery creates heat but cannot dissipate that heat, resulting in dynamic temperature increase. Initial signs of thermal runaway might include pressure increase at the cell level, temperature increase, and off-gassing. As the process continues, additional signs might include vent gas ignition, exploding cells, projectile release, heat propagation, and flame propagation. As the failure cascades, responders should also be prepared for toxic and highly toxic emissions and potentially explosive gas release. Though fire and explosion testing in accordance with 9.5.3.2 to determine battery burn outcomes, including toxic gas release calculations, remains incomplete, responders should treat them as highly dangerous and use their full suite of PPE and breathing apparatus when responding. Proper response to electrochemical ESS fires should include the following procedures and steps: (1) System isolation and shutdown		

	(2) Hazard confinement and exposure protection (3) Fire suppression (4) Ventilation
Statement (technical reason for FR)	This revision includes the danger of highly toxic emissions for which fire fighters and first responders need to be aware. These are industry accepted technical terms with definitions for both.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
C.5.1	331	None	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	C.5.1 Lithium-Ion (Li-ion) Batteries. Water or water with a water addtive, Ecnpasulating Agent (EA), is considered the preferred agent for suppressing lithium-ion battery fires. Water has superior cooling capacity, is plentiful (in many areas), and is easy to transport to the seat of the fire. While water or water with an encapsulating agent (EA) might be the ~~agent~~ agents of choice, the module/cabinet configuration could make penetration of water difficult for cooling the area of origin, but might still be effective for containment. Water spray has been deemed safe as an agent for use on high-voltage systems. The possibility of current leakage back to the nozzle, and ultimately the firefighter, is insignificant based on testing data published in the Fire Protection Research Foundation report *Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results*. Firefighting foams are not considered to be effective for these chemistries because they lack the ability to cool sufficiently and can conduct electricity. There is also some evidence that foams might actually encourage thermal runaway progression by insulating the burning materials and exacerbating heat rise. Firefighting dry chemical powders can eliminate visible flame. However, they also lack the ability to cool burning battery components. Quite often, even if visible flame is removed, the thermal runaway inside the battery will continue resulting in reignition. Carbon dioxide and inert gas suppressing agents will also eliminate visible flame but will likely not provide sufficient cooling to interrupt the thermal runaway process. ESS with clean agent suppression systems installed have ventilation systems that are tied in with the fire detection and control panel so that the HVAC shuts down and dampers close to ensure the agents have sufficient hold times at the proper concentration levels to be effective suppressants. In some fire suppression systems, the HVAC recirculates and does not shut down and provides a means of dispersing the clean agents. Responders must ensure adequate hold time has occurred prior to accessing battery room/container. Manufacturer-recommended times should be made clear. These agents might also reduce flammability by suppressing oxygen levels, but data has identified that flammable gases will continue to be produced due to the continued heating and could create an environment ripe for flashover or backdraft when oxygen is reintroduced into the system.

First Revision Text (FR)	
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	This is presented as a technical fact and thus the proposed text reads more like a sales/marketing statement than a technical rationalization. Additional technical documentation, large scale fire testing, and proper testing results need to be presented. This should include testing in a loaded rack configuration with close module spacing.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New F.2.9 and F.2.10	349	None	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	F2.9 NFPA 18A 2022 Edition includes an Encapsulator- Spherical Micelle Stability Test (Liquid phase fuels). This test allow water additives to be tested to a standard, making the use of NFPA 18A agents more readily accepted. F2.10 NIOSH conducted a Comparison of Fire Suppression Techniques on Lithium Ion Battery Pack Fires that concluded that a water mist system with F-500 (an Encapsulator Agent (EA)) can better suppress a Lithium-ion battery fire.		
First Revision Text (FR)			
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	This is presented as a technical fact and thus the proposed text reads more like a sales/marketing statement than a technical rationalization. Additional technical documentation, large scale fire testing, and proper testing results need to be presented. This should include testing in a loaded rack configuration with close module spacing.		

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
H.1.1	211	369	☐ Create First Revision ☒ Resolve
Proposed Text (PI)	H.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471. NFPA 1, *Fire Code*, 2021 edition. NFPA 10, *Standard for Portable Fire Extinguishers*, 2022 edition.		

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2022 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2021 edition.

NFPA 18A, Standard on Water Additives for Fire Control and Vapor Mitigation

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2022 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 70®, National Electrical Code®, 2023 edition.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2022 edition.

NFPA *70E®, Standard for Electrical Safety in the Workplace®*, 2021 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2022 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*, 2020 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2022 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2021 edition.

NFPA *101®, Life Safety Code®*, 2021 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2022 edition.

NFPA 204, *Standard for Smoke and Heat Venting,* 2021 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

	NFPA 550, *Guide to the Fire Safety Concepts Tree,* 2022 edition. NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2022 edition. NFPA 652, *Standard on the Fundamentals of Combustible Dust*, 2019 edition. NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2022 edition. NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition. NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2020 edition. NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2020 edition. NFPA 921, *Guide for Fire and Explosion Investigations*, 2021 edition. NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition. NFPA 1620, *Standard for Pre-Incident Planning*, 2020 edition. NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition. NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition. NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2020 edition. *Fire Protection Handbook*, ~~20th~~ 21st edition, ~~2008~~2023.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	Public inputs referencing encapsulating agents were rejected. See Public Inputs 269, 330,331 and 349 for technical substantiation for rejecting inclusion of encapsulating agents. Therefore, this document should not reference NFPA 18A.		
H.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	369	~~211~~	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	H.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471. NFPA 1, *Fire Code*, 2021 edition.		

	NFPA 10, *Standard for Portable Fire Extinguishers*, 2022 edition. NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2022 edition. NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2022 edition. NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition. NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition. NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition. NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2021 edition. NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2018 edition. NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2022 edition. NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition. NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2018 edition. NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition. *NFPA 70®, National Electrical Code®*, 2023 edition. NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2022 edition. NFPA *70E®, Standard for Electrical Safety in the Workplace®*, 2021 edition. *NFPA 72®, National Fire Alarm and Signaling Code®*, 2022 edition. NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*, 2020 edition. NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2022 edition. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2021 edition. NFPA *101®, Life Safety Code®*, 2021 edition. NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition. NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2022 edition. NFPA 204, *Standard for Smoke and Heat Venting,* 2021 edition. NFPA 400, *Hazardous Materials Code*, 2022 edition. NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition. NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

	NFPA 550, *Guide to the Fire Safety Concepts Tree,* 2022 edition. NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2022 edition. NFPA 652, *Standard on the Fundamentals of Combustible Dust*, 2019 edition. NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2022 edition. NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition. NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2020 edition. NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2020 edition. NFPA 921, *Guide for Fire and Explosion Investigations*, 2021 edition. NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition. NFPA 1620, *Standard for Pre-Incident Planning*, 2020 edition. NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition. NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition. NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2020 edition. *Fire Protection Handbook*, 20th edition, 2008.
First Revision Text (FR)	See below for revised text.
Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	

H.1.1	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	369		☒~~☐~~ Create First Revision ☐- Resolve

Proposed Text (PI)	
First Revision Text (FR)	See below for revised text.

Statement (technical reason for FR)	
Response (technical reason for not making some changes or for resolving)	
First Revision Text (FR)	

H.1.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2021 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2022 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2022 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, ~~2021~~ 2024 edition

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, ~~2018~~ 2023 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2022 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, ~~2018~~ 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 70®, National Electrical Code®, 2023 edition.

NFPA 70B, *Standard for Electrical Equipment Maintenance, 2023 Edition*~~*Recommended Practice for Electrical Equipment Maintenance*, 2022 edition~~.

NFPA *70E®, Standard for Electrical Safety in the Workplace®*, ~~2021~~ 2024 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2022 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*, 2020 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2022 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, ~~2021~~ 2024 edition.

NFPA *101*®*, Life Safety Code*®, 2021 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2022 edition.

NFPA 204, *Standard for Smoke and Heat Venting,* 2021 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*, 2021 edition.

NFPA 550, *Guide to the Fire Safety Concepts Tree,* 2022 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2022 edition.

NFPA 652, *Standard on the Fundamentals of Combustible Dust*, 2019 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2022 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2020 edition.

NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2020 edition.

NFPA 921, *Guide for Fire and Explosion Investigations*, 2021 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition.

NFPA 1620, *Standard for Pre-Incident Planning*, 2020 edition.

NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition.

NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2020 edition.

Fire Protection Handbook, ~~20th~~ 21st edition, ~~2008~~2023.

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
H.1.2.11	304	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	H.1.2.11 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.		

	UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021. UL 1642, *Lithium Batteries*, 2020, revised 2022. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, ~~2018~~2023. UL 1778, *Uninterruptible Power Systems*, ~~2017~~2014, revised 2023. CAN/UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,*~~ 2018~~ 2022. CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2018. UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020. ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019. UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019. UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2021. CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.
First Revision Text (FR)	H.1.2.11 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. UL 1012, *Power Units Other Than Class 2*, 2010 revised 2021. UL 1642, *Lithium Batteries*, 2020 revised 2022. UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*~~, 2018 ~~2023. UL 1778, *Uninterruptible Power Systems*,~~ 2017 ~~2014 revised 2023. CAN/UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* ~~2018 ~~2022. CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2018. UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020. ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019. UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019. UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2021. CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.

Statement (technical reason for FR)	This updates the publications to the current revision date of publication.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
H.1.2.14.1	131	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	H.1.2.14.1 References for Annex D. 1. International Electrotechnical Commission (IEC), “Electrical Energy Storage,” White Paper, Geneva/Switzerland, pp. 17–34, December 2011. 2. Rastler, D., “Electricity Energy Storage Technology Option,” Electric Power Research Institute, December 2010. 3. Doetsch, C., “Electrical energy storage from 100 kW—State of the art technologies, fields of use,” 2nd International Renewable Energy Storage Conference, Bonn, Germany, November 2007. 4. Xie, S., and L. S. Wang, “Industry Trends — Issue 9,” China Energy Storage Alliance, January 2012. 5. The ADELE project in Germany uses adiabatic compression, while the SustainX, General Compression, and LightSail projects in the US use isothermal compression. See “ADELE — Adiabatic Compressed-Air Energy Storage (CAES) for Electricity Supply,” RWE; “SustainX's ICAES,” SustainX; and “General Compression, Who We Are,” General Compression. 6. Nakhamkin, M., “Novel Compressed Air Energy Storage Concepts,” developed by Energy Storage and Power Consultants (ESPC) and presented to EESAT, May 2007. 7. Inage, Shin-ichi, “Prospects for Large-Scale Energy Storage in Decarbonised Grids,” International Energy Agency, Report, 2009. 8. Schossig, P., “Thermal Energy Storage,” 3rd International Renewable Energy Storage Conference, Berlin, Germany, November 2012. 9. Fairley, P., http://spectrum.ieee.org/energy/environment/largest-solar-thermal-storage-plant-to-start-up, Article 2008, Accessed ~~July 2011~~ May 2023. 10. Jahnig D. et al., “Thermo-chemical storage for solar space heating in a single-family house,” 10th International Conference on Thermal Energy Storage, Ecostock 2006, New Jersey, May/June 2006. 11. Tamme, R., “Development of Storage Systems for SP Plants,” DG TREN—DG RTD Consultative Seminar on Concentrating Solar Power, Brussels, Belgium, June 2006.		

	12. Bullough, C., “Advanced Adiabatic Compressed Air Energy Storage for the Integration of Wind Energy,” European Wind Energy Conference and Exhibition, London, GB, November 2004.
First Revision Text (FR)	

H.1.2.14.1 References for Annex D.

1. International Electrotechnical Commission (IEC), “Electrical Energy Storage,” White Paper, Geneva/Switzerland, pp. 17–34, December 2011.

2. Rastler, D., “Electricity Energy Storage Technology Option,” Electric Power Research Institute, December 2010.

3. Doetsch, C., “Electrical energy storage from 100 kW—State of the art technologies, fields of use,” 2nd International Renewable Energy Storage Conference, Bonn, Germany, November 2007.

4. Xie, S., and L. S. Wang, “Industry Trends — Issue 9,” China Energy Storage Alliance, January 2012.

5. ~~The ADELE project in Germany uses adiabatic compression, while the SustainX, General Compression, and LightSail projects in the US use isothermal compression. See~~ “ADELE — Adiabatic Compressed-Air Energy Storage (CAES) for Electricity Supply,” RWE; “SustainX's ICAES,” SustainX; and “General Compression, Who We Are,” General Compression.

6. Nakhamkin, M., “Novel Compressed Air Energy Storage Concepts,” developed by Energy Storage and Power Consultants (ESPC) and presented to EESAT, May 2007.

7. Inage, Shin-ichi, “Prospects for Large-Scale Energy Storage in Decarbonised Grids,” International Energy Agency, Report, 2009.

8. Schossig, P., “Thermal Energy Storage,” 3rd International Renewable Energy Storage Conference, Berlin, Germany, November 2012.

9. Fairley, P., http://spectrum.ieee.org/energy/environment/largest-solar-thermal-storage-plant-to-start-up, Article 2008~~, Accessed July 2011~~.

10. Jahnig D. et al., “Thermo-chemical storage for solar space heating in a single-family house,” 10th International Conference on Thermal Energy Storage, Ecostock 2006, New Jersey, May/June 2006.

11. Tamme, R., “Development of Storage Systems for SP Plants,” DG TREN—DG RTD Consultative Seminar on Concentrating Solar Power, Brussels, Belgium, June 2006.

12. Bullough, C., “Advanced Adiabatic Compressed Air Energy Storage for the Integration of Wind Energy,” European Wind Energy Conference and Exhibition, London, GB, November 2004.

Statement (technical reason for FR)	It is not customary or necessary to show that the paper was accessed on any given date (H.1.2.14.1.9) and corrects H.1.2.14.1.5 to be consistent with all the other references.

Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
H.1.2.14.2.3	306	None	☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)	H.1.2.14.2.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, ~~2021~~2019.		
First Revision Text (FR)	H.1.2.14.2.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, ~~2021~~ 2019.		
Statement (technical reason for FR)	Revises CAN/UL 9650A heading to reflect correct cosponsorship of this testing document.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
H.1.2.14.3	130	~~370?~~	☐ Create First Revision ☒~~☐~~ Resolve
Proposed Text (PI)	H.1.2.14.3 Other Publications. DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020. Marioff Corporation—Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms,” August 2015.		

	“Fire Safety Testing Data Analysis Supplement for NYC Outdoor ESS,” NY Solar Map, City University of New York (CUNY). https://nysolarmap.com/media/2041/fire-safety-testing-data-analysis-supplement-for-nyc-outdoor-ess_v1.pdf, accessed May 2023.		
First Revision Text (FR)	See below for revised text.		
Statement (technical reason for FR)			
Response (technical reason for not making some changes or for resolving)	It is not necessary to show a particular paper or publication was accessed.		
New H.1.2.14.4 or add to H.1.2.14.3?	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
	370	~~1302~~	☒☐ Create First Revision ☐ Resolve
Proposed Text (PI)	H.1.2.14.3 Other Publications. DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020. Marioff Corporation—Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms,” August 2015. “Fire Safety Testing Data Analysis Supplement for NYC Outdoor ESS,” NY Solar Map, City University of New York (CUNY). https://nysolarmap.com/media/2041/fire-safety-testing-data-analysis-supplement-for-nyc-outdoor-ess_v1.pdf H1.2.14.2.4 NIOSH- Comparison of Fire Suppression Techniques on Lithium Ion Battery Pack Fires		
First Revision Text (FR)	See below for revision.		
Statement (technical reason for FR)	The NIOSH report is a document for reference purposes.		
Response (technical reason for not making some changes or for resolving)	The NIOSH report is just another publication and does not warrant being made a separate section.		
First Revision Text (FR)	H.1.2.14.3 Other Publications. DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020.		

	Marioff Corporation—Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms,” August 2015. “Fire Safety Testing Data Analysis Supplement for NYC Outdoor ESS,” NY Solar Map, City University of New York (CUNY). https://nysolarmap.com/media/2041/fire-safety-testing-data-analysis-supplement-for-nyc-outdoor-ess_v1.pdf NIOSH- Comparison of Fire Suppression Techniques on Lithium Ion Battery Pack Fires

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New definition			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	3.3.X Emergency Power Supply System (EPSS). A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power. [110, 2023]		
Statement (technical reason for FR)	The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. The applications were also in conflict with other codes such as NFPA 72 and 69. Or the references to the other codes provided no clear guidance to the back requirements in a failure event. Additional definitions and a new chapter have been created to consolidate the power requirements and provide consistency.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New definition			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	3.3.X Stored-Energy Emergency Power Supply System (SEPSS). A system consisting of a UPS, a rectifier plant, or a motor generator powered by a stored electrical energy source; a transfer switch designed to monitor preferred and alternate load power source and provide desired switching of the load; and all necessary control equipment to make the system functional. [111, 2023]		
Statement (technical reason for FR)	The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. The applications where also in conflict with other codes such as NFPA 72 and 69. Or the references to the other codes provided no clear guidance to the back requirements in a failure		

	event. Additional definitions and a new chapter have been created to consolidate the power requirements and provide consistency.
Response (technical reason for not making some changes or for resolving)	

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New definition			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	3.3.x* Reliability The probability the system, structure, or component of interest will perform its specified function under given conditions upon demand or for a prescribed time [NFPA 806, 2020]. A.3.3.X Probability performance data is derived from the applicable failure modes and effects analysis. Specified system performance functions are those identified by the original equipment manufacturer in response to credited failure scenarios. All subsystem components relied upon for critical safety systems shall be operable throughout the specified Fault Conditions as evaluated in the HMA. Determining the duration requires chemistry specific performance data (LFP, NMC, other) and shall include project specific location and associated hazards.		
Statement (technical reason for FR)	The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. The applications where also in conflict with other codes such as NFPA 72 and 69. Or the references to the other codes provided no clear guidance to the back requirements in a failure event. Additional definitions and a new chapter have been created to consolidate the power requirements and provide consistency.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION

New definition			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			
First Revision Text (FR)	3.3.x* Critical Safety Component or System A component or system designed to prevent loss of life, serious personal injury, or damage to the natural environment as identified by the HMA or product listing failure modes and effects analysis (FMEA). A.3.3.x Critical safety components or systems shall be identified by a systematic safety evaluation consisting of a comprehensive hazard identification, risk analysis, and risk evaluation. The analysis of the ESS must evaluate whether the various parts of the ESS work compatibly with each other to prevent hazardous conditions from occurring.		
Statement (technical reason for FR)	The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. The applications where also in conflict with other codes such as NFPA 72 and 69. Or the references to the other codes provided no clear guidance to the back requirements in a failure event. Additional definitions and a new chapter have been created to consolidate the power requirements and provide consistency.		
Response (technical reason for not making some changes or for resolving)			

Section	All PIs used for FR or Resolve	Other PIs that propose revisions for this section	MOTION
New 4.10			☒~~☐~~ Create First Revision ☐ Resolve
Proposed Text (PI)			

First Revision Text (FR)	**4.10 Emergency Power Standby systems** Critical safety systems shall be provided with reliable EPSS or SEPSS power. **4.10.1** EPSS or SEPSS shall be a Class X, Type 10, Level 2. **A.4.10.1** The duration of the required EPSS of SEPSS as defined in class X is time, in hours, as required by the application, code, or user. The HMA is used to determine a credible event and the duration of the event. Typically, systems operating in standby mode durations should be a minimum of 24 hours for LIB BESS system. Determining time requirements EPSS or SEPESS systems in alarm mode should be based on probable response times of the SME or first responders. This ensures that the critical safety systems are functional to provide appropriate information to the SME or the first responders. Other references and codes may include the terms secondary power, Standby power, or auxiliary power. For the purposes of safety reliability, they are assumed to have the same requirements as EPSS or SEPSS. **4.10.1.1** EPSS shall comply with NFPA 110 **4.10.1.2** SEPSS shall comply with NFPA 111. **4.10.2*** A registered design professional with fire protection background shall evaluate the duration and total load requirements for the EPSS and SEPSS. **A.4.10.2** A typical evaluation would include all safety system functioning in a failure event. Total load would be based on one BESS system in failure with a safety margin of one additional unit. This evaluation should be supported by 9540A and propagation potential from the large-scale testing. **4.10.3*** EPSS or SEBESS Type 10 requirements shall be permitted to be reduced based on the HMA evaluation and a safe critical infrastructure load transfer. **A.4.10.3** If EPSS is used such as standby diesel generators, the transfer time between the loss of power and engagement of the generators may be greater than 10 seconds for critical safe shut down and transfer of the load to and from the grid. A higher Type may be acceptable for critical infrastructure equipment and the transfer of power is safely completed. If there is a limited UPS to power the critical safety system until the generator starts-up. Then a combination of the two systems would still meet the 10 second transfer time of a Type 10 system. This would be determined by the HMA.
Statement (technical reason for FR)	The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. The applications where also in conflict with other codes such as NFPA 72 and 69. Or the references to the other codes provided no clear guidance to the back requirements in a failure event. Additional definitions and a new chapter have been created to consolidate the power requirements and provide consistency.
Response (technical reason for not making some changes or for resolving)	

BREAKTHROUGH LOW-COST, MULTI-DAY ENERGY STORAGE

Form energy

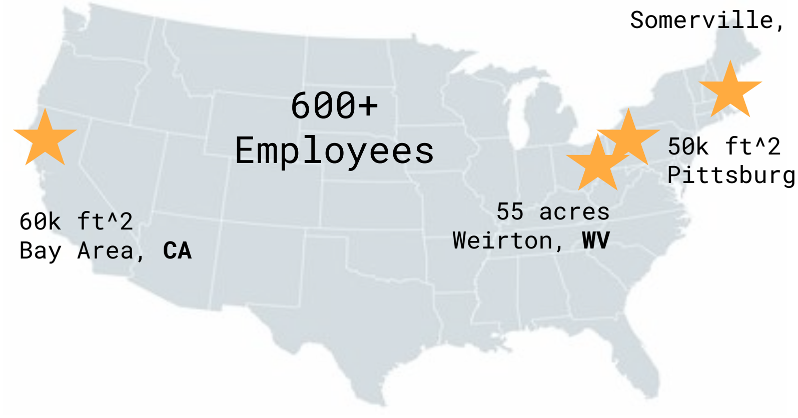
Energy Storage
For A Better World

CONFIDENTIAL

Agenda

- Form Energy Introduction
- Iron-Air Chemistry & Hazards
- Proposed Additions to NFPA 855
- Questions

Rising to the challenge of climate change with a team that will deliver



90k ft^2
Somerville, **MA**

600+
Employees

50k ft^2
Pittsburgh, **PA**

60k ft^2
Bay Area, **CA**

55 acres
Weirton, **WV**

OUR INVESTORS: LONG-TERM AND IMPACT-FOCUSED

$820M+ in venture capital from top investors including: Breakthrough Energy Ventures (BEV), TPG's Climate Rise Fund, Coatue Management, GIP, NGP Energy Technology Partners III, ArcelorMittal, Temasek, Energy Impact Partners, Prelude Ventures, MIT's The Engine, Capricorn Investment Group, Eni Next, Macquarie Capital, Canada Pension Plan Investment Board, and other long-term, impact oriented investors

LED BY ENERGY STORAGE VETERANS

Decades of cumulative experience in energy storage

- 100's of MW of storage deployed

TESLA ENERGY

A123 SYSTEMS

SUNPOWER
FROM MAXEON SOLAR TECHNOLOGIES

24M

NEXTera ENERGY

DEPARTMENT OF JUSTICE

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

amsc

Massachusetts Institute of Technology

AQUION ENERGY

Form energy

Over 5 GWh of Commercial Engagements

GREAT RIVER ENERGY

First-of-its-kind **1.5 MW /150 MWh** MDS project in Cambridge, Minnesota to come online in 2024

Xcel Energy

Two 10 MW / 1,000 MWh MDS systems; one in Becker, MN and one in Pueblo, CO. Both expected to come online as early as 2025

NEW YORK STATE | NYSERDA

10 MW / 1000 MWh MDS system in New York to come online as early as 2025

Georgia Power

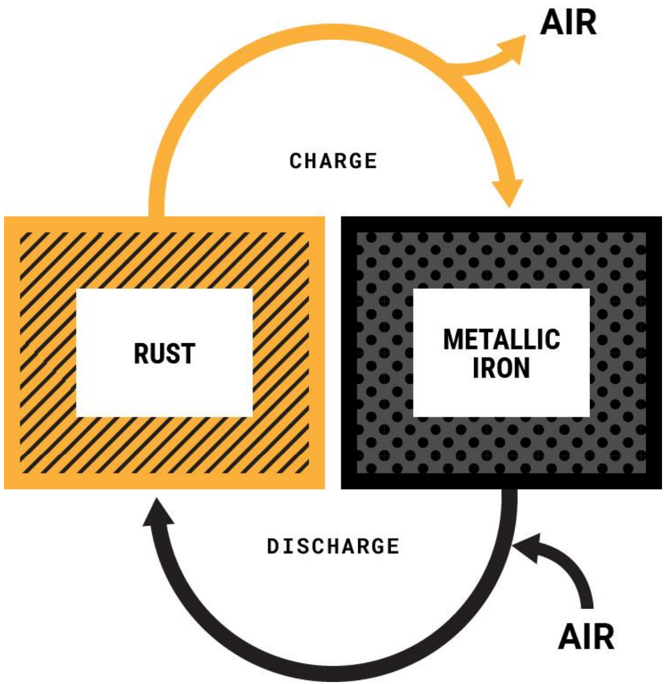
15 MW / 1500 MWh MDS system in Georgia to come online as early as 2026

Dominion Energy

5 MW / 500 MWh MDS system in Virginia to come online as early as 2026

Rechargeable iron-air is the best technology for multi-day storage

Form's 100-Hour Reversible Rust Battery



AIR

CHARGE

RUST

METALLIC IRON

DISCHARGE

AIR

COST

Lowest cost rechargeable battery chemistry.
Less than 1/10th the cost of lithium-ion batteries

SAFETY

Non-flammable aqueous electrolyte. No risk of thermal runaway.

SCALE

Uses materials available at the global scale needed for a zero carbon economy. High recyclability.

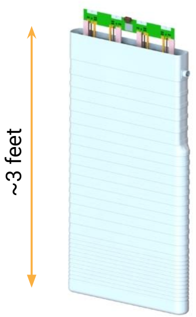
DURABILITY

Iron electrode durability proven through decades of life and 1000's of cycles

What makes up a Form Energy system

Modular design enables easy scaling to GWh systems

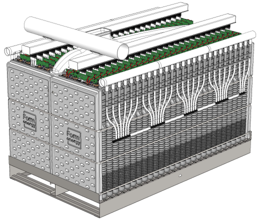
Cell



Electrodes + Electrolyte

Smallest **Electrochemical** Functional Unit

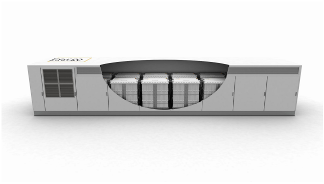
Battery Module



~50 **Cells**

Smallest Building Block of **DC** Power

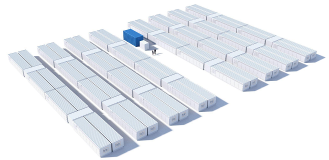
Enclosure



~7 **Modules**

Product Building Block with **integrated module auxiliary systems**

Power Block



~3.5 MW / 350 MWh

<2 acres

~50 - 100 **Enclosures**

Smallest independent system and **AC Power** building block

System

10 MW / 1000 MWh

5+ acres

10s - 100s of **Power Blocks**

Commercial Intent System

NFPA 855 Proposal | Iron-Air Addition to Threshold & Max Energy Tables

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	**kWh**	**MJ**
Battery ESS		
Lead-acid, all types	70	252
Ni-Cad, Ni-MH, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70)	72 (252)
Flow batteries	20	72
Iron-air	**20**	**72**
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy (kWh)**
Lead-acid batteries, all types	Unlimited
Nickel batteries	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600
Flow batteries	600
Iron-air batteries	**600**
Other battery technologies	200
Storage capacitors	20

Justification

- → *Recommended that iron-air technology be separately listed (and not covered under "other" technologies) because it has additional safety benefits that will be seen in other sections (Table 9.6.5).*
- → *Energy limits were selected because iron-air is demonstrated to be equivalent to or safer than other chemistries listed at those quantities.*

NFPA 855 Proposal | 9.6.5 Iron-Air Addition

→ *Form Energy proposes adding iron-air specific requirements where thermal runaway protection & explosion control are not required.*

Table 9.6.5 Electrochemical ESS Technology-Specific Requirements

Compliance Requirement	**Lead- Acid**	**Ni-Cd, Ni-MH, Ni-Zn**	**Lithium-Ion**	**Flow**	**Sodium Nickel Chloride**	**Iron-Air**	**EDLC Energy Storage**	**Other Battery Tech**	**Reference**
Exhaust Ventilation	Yes	Yes	No	Yes	No	Yes	Yes	Yes	9.6.5.1
Spill Control	Yes[1]	Yes[1]	No	Yes	No	Yes	Yes	Yes	9.6.5.2
Neutralization	Yes[1]	Yes[1]	No	Yes	No	Yes	Yes	Yes	9.6.5.3
Safety Caps	Yes	Yes	No	No	No	Yes	Yes	Yes	9.6.5.4
Thermal Runaway	Yes	Yes	Yes	No	Yes	No	Yes	Yes	9.6.5.5
Explosion Control	Yes	Yes	Yes	No	Yes	~~Yes~~ No	Yes	Yes	9.6.5.6

Justification

- → *Spill control and neutralization requirements are recommended requirements due to caustic electrolyte.*
- → *Exhaust ventilation and safety caps are recommended requirements due to hydrogen evolution from aqueous electrolyte.*
- → *Thermal runaway protection is not a recommended requirement due to the inability to induce thermal runaway in iron-air chemistry.*
- → *Explosion control is not a recommended requirement because hydrogen evolution rates are the same during normal operation and abuse cases (overcharge), and therefore is covered by the exhaust ventilation requirement.*
  - ◆ *Proposal updated from original submittal based on feedback from Task Group 8.*

Iron-air chemistry: no failure modes induce thermal runaway

NO SAFETY RISK FROM INTERNAL SHORT

No spontaneous reaction occurs when iron and air electrodes are in direct contact.

NO SAFETY RISK FROM EXTERNAL SHORT

Discharging requires blowing air (oxygen) in. Discharge rates are limited by air flow.

NO SAFETY RISK FROM HIGH CHARGE RATES

The charge reaction has no positive thermal feedback loops: charging bubbles oxygen out, which rejects heat from the cell

NO RISK OF DENDRITE FORMATION

Iron is only sparingly soluble in the electrolyte, forming a conformal layer on discharge; dendrite formation not possible

NFPA 855 Proposal | 9.6.5.4 Safety Caps

9.6.5.4 Safety Caps

Where required by Table 9.6.5, vented batteries used in ESS shall be provided with flame-arresting safety caps.

Flame-arresting safety caps shall not be required if flame-arresting is achieved through other design mechanisms. Alternative flame-arresting methods to safety caps shall be reviewed and approved by a third-party FPE.

Justification

- ➔ *Form Energy recommends that a flame arresting mechanism be required for iron-air chemistry due to potential hydrogen generation.*
- ➔ *It is recommended that safety caps are not the only approved method for flame arresting. This proposed addition allows for innovative designs while still achieving the same level of product safety.*
- ➔ *Data collection validating this proposal is in process.*

NFPA 855 Proposal | B.5.8 Metal Air Batteries

Annex B - Battery Energy Storage System Hazards

B.5.8 Metal Air Batteries - General Description

Metal-air batteries have a metal anode (negative electrode) and an air “breathing” cathode (positive electrode) with an aqueous alkaline electrolyte. The combination of a metal anode with an air cathode provides an inexhaustible cathode reactant and the potential for high energy density. The capacity limit is determined by the amp-hour capacity of the anode and the means used to address reaction products. Metal air batteries are available in primary (non-rechargeable), reserve, and secondary (rechargeable) designs. The secondary designs can be either electrically rechargeable or mechanically rechargeable (replacing the discharged metal electrode) configurations. Electrical recharging of metal-air batteries requires either a third electrode (to sustain oxygen evolution on charge) or a bi-functional electrode (a single electrode capable of both oxygen reduction and evolution). This section of Annex B covers the electrical recharging designs. There are multiple technologies under the electrically rechargeable metal air battery category including iron-air batteries, zinc-air batteries, and magnesium-air batteries.

B.5.8.1 Iron-Air Batteries. Hazard considerations for iron-air batteries under normal operating conditions are as follows:

(1) *Fire hazards:* There is the potential for concentrations of hydrogen from iron-air batteries if the area where the batteries are located is not properly ventilated. However, this should be taken care of if the installation complies with the codes.
(2) *Chemical hazards:* These batteries have caustic electrolyte that is contained within the system during normal operation. Exposure risks may occur when handling electrolyte as a part of commissioning, decommissioning, and maintenance. Workers handling electrolyte need to use proper PPE.
(3) *Electrical hazards:* There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.
(4) *Stranded or stored energy hazards:* Not applicable.
(5) *Physical hazards:* Not applicable.

Hazard considerations for iron-air batteries under emergency/abnormal conditions are as follows:

(1) *Fire hazards:* These systems have aqueous electrolytes, so the potential of hydrogen concentration buildup exists if the area where the batteries are located is not properly ventilated.
(2) *Chemical hazards:* There is the potential for contact with caustic electrolyte during abnormal conditions should electrolyte leak. First responders, in emergency situations, need to be aware of potential caustic electrolyte spills that can occur and use appropriate caution around these batteries.
(3) *Electrical hazards:* Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.
(4) *Stranded or stored energy hazards:* Not applicable.
(5) *Physical hazards:* The potential exists for overheating due to severe electrolyte loss from a leak. Exposure to moving parts such as fans where guards may be missing.

Questions?

Public Comment No. 354-NFPA 855-2024 [Global Input]

NOTE: This public input originates from Tentative Interim Amendment No. 23-1 (Log No. 1727) issued by the Standards Council on August 25, 2023 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

1. Revise paragraph 15.3.1 to read as follows:
15.3.1 ESS Spacing. Individual ESS units shall be separated from each other by a minimum of 3 ft (914 mm) unless
smaller separation distances are documented to be adequate based on fire and explosion testing complying with
9.1.515.13.
2. Add new section 15.12 and associated Annex text to read as follows:
15.12* Test Reports. ESS installed in accordance with Chapter 15 shall be provided with a product-level evaluation by
an approved qualified person with expertise in energy storage as a supplemental safety document to be used by the AHJ
and the installing contractors.
A.15.12 The test report will provide information that, among other things, describes the size and energy capacity rating of
the unit being tested, model numbers of the modules and ESS units, orientation of ESS in the test facility, and proximity
of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of
test results and measurements. For example, a complete UL 9540A test report that includes a unit-level test should also
include the UL 9540A cell and module-level test.
3. Add new section 15.13 and associated Annex text to read as follows:
15.13 Fire and Explosion Testing.
15.13.1* Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance
with UL 9540A or equivalent test standards.
A.15.13.1 A UL 9540A or equivalent test should evaluate the fire characteristics of the composition of gases generated at
the cell, module, and unit and installation levels for ESS undergoing thermal runaways, such as what might occur due to a
fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unitlevel
and installation-level testing should document whether the fire event propagates to the neighboring ESS units and
include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at
the unit level. The fire and explosion testing data is intended to be used by manufacturers, system designers, and AHJs to
determine if the required separation distance for an ESS installation can be reduced.
15.13.1.1 The complete UL 9540A or equivalent test report shall be provided to the authority having jurisdiction,
including the cell, module, and unit level.
15.13.1.2 Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require
UL 9540A testing when installed with a charging system listed to UL 1012, UL 60950-1, or UL 62368-1, or a UPS listed
to UL 1778.
15.13.1.3 The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the
composition of the gases generated and show that a fire involving one ESS unit will not

propagate to an adjacent unit.
15.13.1.4* The representative cell, modules, and units tested, including any optional integral fire suppression system, shall
match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal
runaway initiation.
A.15.13.1.4 Changes in an installation configuration, including the internal architecture of modules and units that don't
match the parameters tested, such as size and separation, cell type, or energy density, should only be accepted if it can be
shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to
conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located
on a mezzanine floor above, or back-to-back units. These configurations might have yet to be evaluated in the test.
15.13.1.5 The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.

Additional Proposed Changes

File Name	Description	Approved
TIA_855_23_1_1727.pdf	855_23_1_1727	

Statement of Problem and Substantiation for Public Comment

NOTE: This public input originates from Tentative Interim Amendment No. 23-1 (Log No. 1727) issued by the Standards Council on August 25, 2023 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

Substantiation: The standard contains a conflict that developed during the regular revision process. The proposed TIA intends to correct a circumstance in which the revised NFPA Standard has resulted in an adverse impact on a product or method that was inadvertently overlooked in the total revision process or was without adequate technical (safety) justification of the action.
This TIA would eliminate the requirement for a registered design professional with fire protection engineering expertise for detached one-and two-family dwellings and townhouse installations and replace that with language similar to what is currently found in NFPA 1, Section 1.16.1 when technical assistance is required by the AHJ (the IFC has similar language in 104.8.2). This allows the current language to be onerous for the smaller residential installations. It allows an approved third party with expertise in energy storage to review the documents and provide the supplemental report.
As currently written, an installer could do the same installation at several homes in a jurisdiction, and they would need a registered design professional (e.g., FPE) for each installation. The new Section matches how this topic (technical assistance for supplemental reports) is addressed in NFPA 1 Fire Code.

Emergency Nature: The proposed TIA intends to correct a previously unknown existing hazard. The standard contains an error or an omission overlooked during the regular revision processes. The proposed TIA intends to correct a circumstance in which the revised NFPA Standard has adversely impacted a product or method that was inadvertently overlooked in the total revision process without adequate technical (safety) justification. When Section 9.1.5.2.2 was added to the code, the submitters did not consider the impact on small residential installations. Only lager commercial installations were considered. Section 15.3.1 requires fire and explosion testing for smaller, more standardized residential SS systems and must remove any reference to chapter 9.

Related Item

- Tentative Interim Amendment No. 1727

Submitter Information Verification

Submitter Full Name: NFPA TIA
Organization: Technical Committee on Energy Storage Systems
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Submittal Date: Tue Jun 04 16:31:58 EDT 2024
Committee: ESS-AAA

Tentative Interim Amendment

NFPA® 855

Standard for the Installation of Stationary Energy Storage Systems

2023 Edition

Reference: 15.3.1, 15.12(new), and 5.13(new)
TIA 23-1
(SC 23-8-64 / TIA Log #1727)

Pursuant to Section 5 of the NFPA *Regulations Governing the Development of NFPA Standards*, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, 2023 edition. The TIA was processed by the Technical Committee on Energy Storage Systems, and was issued by the Standards Council on August 25, 2023, with an effective date of September 14, 2023.

1. Revise paragraph 15.3.1 to read as follows:

15.3.1 ESS Spacing. Individual ESS units shall be separated from each other by a minimum of 3 ft (914 mm) unless smaller separation distances are documented to be adequate based on fire and explosion testing complying with ~~9.1.5~~15.13.

2. Add new section 15.12 and associated Annex text to read as follows:

15.12* Test Reports. ESS installed in accordance with Chapter 15 shall be provided with a product-level evaluation by an approved qualified person with expertise in energy storage as a supplemental safety document to be used by the AHJ and the installing contractors.

A.15.12 The test report will provide information that, among other things, describes the size and energy capacity rating of the unit being tested, model numbers of the modules and ESS units, orientation of ESS in the test facility, and proximity of the ESS unit under test to adjacent ESS, walls, and monitoring sensors. The test report also includes a complete set of test results and measurements. For example, a complete UL 9540A test report that includes a unit-level test should also include the UL 9540A cell and module-level test.

3. Add new section 15.13 and associated Annex text to read as follows:

15.13 Fire and Explosion Testing.

15.13.1* Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standards.

A.15.13.1 A UL 9540A or equivalent test should evaluate the fire characteristics of the composition of gases generated at the cell, module, and unit and installation levels for ESS undergoing thermal runaways, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit-level and installation-level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The fire and explosion testing data is intended to be used by manufacturers, system designers, and AHJs to determine if the required separation distance for an ESS installation can be reduced.

15.13.1.1 The complete UL 9540A or equivalent test report shall be provided to the authority having jurisdiction, including the cell, module, and unit level.

15.13.1.2 Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when installed with a charging system listed to UL 1012, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778.

15.13.1.3 The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.

15.13.1.4* The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation.

A.15.13.1.4 Changes in an installation configuration, including the internal architecture of modules and units that don't match the parameters tested, such as size and separation, cell type, or energy density, should only be accepted if it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might have yet to be evaluated in the test.

15.13.1.5 The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.

Issue Date: August 25, 2023

Effective Date: September 14, 2023

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/docinfo**)**

Public Comment No. 113-NFPA 855-2024 [Section No. 1.1]

1.1* Scope.

This standard applies to the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems (ESSs), including mobile and portable ESSs installed in a stationary situation and the storage of lithium metal or lithium-ion batteries used in stationary ESSs .

Statement of Problem and Substantiation for Public Comment

the current wording of the last portion of the scope seems to indicate that this standard applies to storage of all lithium metal and lithium batteries. the proposed change is intended to help clarify, and provide consistency, that the standard only applies to the storage of lithium metal and lithium batteries that are used in stationary ESSs.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 114-NFPA 855-2024 [Section No. 14.1 [Excluding any Sub-Sections]]	

Related Item

- Scope

Submitter Information Verification

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Submittal Date: Mon May 20 09:39:08 EDT 2024
Committee: ESS-AAA

Public Comment No. 258-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		-
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO$_2$)	20	72
Flow batteries[c]	20	72
Iron-air ~~and zinc~~	70	252
Zinc -air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		-
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		-
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Additional Proposed Changes

File Name	Description	Approved
Table_1.3-_NFPA_855_First_Draft_Public_Comment_.pdf		

Statement of Problem and Substantiation for Public Comment

It is recommended to separate iron-air and zinc-air in Tables 1.3 and 9.4.1. Zinc-air chemistry has the ability to form dendrites and iron-air chemistry is not able to form dendrites. This results in a difference in hazard profiles between the two chemistries, and as a result should not be grouped together in the tables throughout the text.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 259-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	

Related Item

- FR-3

Submitter Information Verification

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Committee:	ESS-AAA

NFPA 855: First Draft Public Comment

The following document outlines Form Energy's submission for the NFPA 855 First Draft Public Comment. Changes to the first draft are outlined in red.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESS Technology	**kWh**	**MJ**
Battery ESS		
Lead-acid, all types	70	252
Ni-Cad, Ni-MH, Ni-Fe, and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70)	72 (252)
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO2)	20	72
Flow batteries	20	72
Iron-air ~~and zinc-air~~	70	252
Zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6

Public Comment No. 279-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

	Aggregate Capacity[a]	
ESSs Technology	kWh	MJ
Battery ESSs		-
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium ~~nickel chloride~~ metal chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide ($Zn\text{-}MnO_2$)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		-
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		-
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Statement of Problem and Substantiation for Public Comment

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 281-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	FR-4
Public Comment No. 282-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	FR-146
Public Comment No. 281-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	
Public Comment No. 282-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	

Related Item

- FR-3

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 287-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		-
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium ~~nickel~~ metal chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO_2)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		-
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		-
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-~~nickel~~ metal -chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Additional Proposed Changes

File Name	Description	Approved
First_Revision_No._3-NFPA_855-2023_Section_No._1.3.docx	Description of rationale for change of "sodium nickel chloride" to "sodium metal chloride"	

Statement of Problem and Substantiation for Public Comment

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in the 1998 paper from NREL "Current Status of Health and Safety Issues of Sodium/Metal Chloride (Zebra) Batteries" documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Item

- FR-3
- FR-4
- FR-146

Submitter Information Verification

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Submittal Date: Thu May 30 11:22:16 EDT 2024
Committee: ESS-AAA

Response to:

First Revision No. 3-NFPA 855-2023 [Section No. 1.3 [Excluding any Sub-Sections]]

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Public Comment No. 303-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		-
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide ($Zn-MnO_2$)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		-
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		-
~~All other ESSs~~	~~70~~	~~252~~
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Statement of Problem and Substantiation for Public Comment

This comment further updates table 1.3 to delete the section on "other ESSs". A task group was established under the technical committee for new technologies. TG8 felt with the addition of new technologies in the table during the first revision, the "other ESS" category was appropriately covered in the line covered for other technologies in the table

Related Item

- FR-3

Submitter Information Verification

Submitter Full Name:	Michael O`Brian
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Submittal Date:	Thu May 30 13:30:30 EDT 2024
Committee:	ESS-AAA

Public Comment No. 308-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO_2)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Additional Proposed Changes

File Name	Description	Approved
NFPA_855_TG_8_-_Tables_Clean_Up_v1_240520_.pdf		

Statement of Problem and Substantiation for Public Comment

This is a comment to revise the associated table to match the format in previous tables. This proposal aligns the order of the chemistries and technologies across tables 1.3, 9.4.1, and 9.6.6 There are no proposed technical changes. For ease of use, the table in terra-view is not modified. The submitted attachment should be based on the lower table found appropriate for this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 307-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	
Public Comment No. 309-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	
Public Comment No. 307-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	
Public Comment No. 309-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	

Related Item

- FR-3

Submitter Information Verification

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Submittal Date:	Thu May 30 13:51:15 EDT 2024
Committee:	ESS-AAA

NFPA 855, Task Group 8, New Technologies - Updated Tables 1.3, 9.4.1 and 9.6.6

Version 1, May 20, 2024 (A. Skoskiewicz)

1) Standardized the technology language used in all 3 tables
2) Alphabetized the tables, with "Other" being last
3) Switched to proper footnote callouts (a, b, c), instead of (*, +) and re-arranged sequence
4) Introduced metric conversion to Table 9.4.1 (similar to Table 1.3)
5) Original Screenshots presented first (row 15+), followed by proposed table (row 50+), followed by "Original Table, digital" (row 80+)
6) Proposed Tables have strikethroughs (deleted text) and underlines (added text). No markings for moved text.
7) Added footnotes "b" and "c" to Table 9.6.6 for consistency
8) Added "Reference Line" as part of the Table 9.6.6 Header.
9) Created a single "Other" bucket to lower ambiguity.

SCREENSHOTS **SCREENSHOTS** **SCREENSHOTS** **SCREENSHOTS** **SCREENSHOTS** **SCREENSHOTS** **SCREENSHOTS** **SCREENSHOTS**

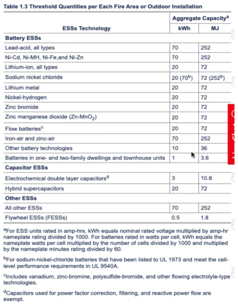

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO_2)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

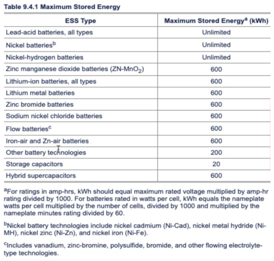

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries (ZN-MnO_2)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

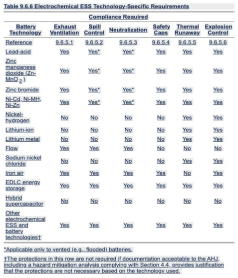

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

PROPOSED TABLES **PROPOSED TABLES** **PROPOSED TABLES** **PROPOSED TABLES** **PROPOSED TABLES** **PROPOSED TABLES** **PROPOSED TABLES** **PROPOSED TABLES**

PROPOSED - Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation

	ESS Technology Type	**Aggregate Capacity[a]**	
		kWh	**MJ**
1	Batteries in one- and two-family dwellings and townhouse units	1	3.6
2	Electrochemical double layer capacitors (EDLC)[b]	3	10.8
3	Flow batteries[c]	20	72
4	Flywheel ESSs (FESSs)	0.5	1.8
5	Hybrid supercapacitors	20	72
6	Iron-air and zinc-air	70	252
7	Lead-acid, all types	70	252
8	Lithium-ion, all types	20	72
9	Lithium metal	20	72
10	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
11	Nickel-hydrogen	20	72
12	Sodium nickel chloride	20 (70)[d]	72 (252)[d]
13	Zinc bromide	20	72
14	Zinc manganese dioxide (Zn-MnO_2)	20	72
15	All other ESSs technologies	10	36

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

PROPOSED - Table 9.4.1 Maximum Stored Energy

	ESS Technology Type	**Maximum Stored Energy[a] (kWh)**	
		kWh	MJ
1	Electrochemical double layer capacitors (EDLC)[b] ~~Storage capacitors~~	20	72
2	Flow batteries[c]	600	2160
3	Hybrid supercapacitors	600	2160
4	Iron-air and ~~Zn~~ zinc-air batteries	600	2160
5	Lead-acid ~~batteries~~, all types	Unlimited	Unlimited
6	Lithium-ion ~~batteries~~, all types	600	2160
7	Lithium metal ~~batteries~~	600	2160
8	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn ~~Nickel batteries~~[d]	Unlimited	Unlimited
9	Nickel-hydrogen ~~batteries~~	Unlimited	Unlimited
10	Sodium nickel chloride ~~batteries~~	600	2160
11	Zinc bromide	600	2160
12	Zinc manganese dioxide batteries (Zn-MnO_2)	600	2160
13	All other ESS ~~battery~~ technologies	200	720

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

~~[d] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)~~

PROPOSED - Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	~~**Battery Technology**~~ **ESS Technology Type**	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
	Reference	**9.6.5.1**	**9.6.5.2**	**9.6.5.3**	**9.6.5.4**	**9.6.5.5**	**9.6.5.6**
1	Electrochemical double layer capacitors (EDLC)[b] ~~energy storage~~	Yes	Yes	Yes	Yes	Yes	Yes
2	Flow batteries[c]	Yes	Yes	Yes	No	No	No
3	Hybrid supercapacitors	No	No	No	No	No	No
4	Iron air and zinc-air	Yes	Yes	Yes	Yes	No	Yes
5	Lead-acid, all types	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
6	Lithium-ion, all types	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Ni-Cd, Ni-MH, Ni-Fe, and Ni-Zn	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
9	Nickel-hydrogen	No	No	No	No	Yes	Yes
10	Sodium nickel chloride	No	No	No	No	Yes	Yes
11	Zinc bromide	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
12	Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
13	All other ~~electrochemical~~ ESS ~~and battery~~ techologies[b]	Yes	Yes	Yes	Yes	Yes	Yes

[a] Applicable only to vented (e.g. flooded) batteries

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[b] The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

ORIGINAL TABLES **ORIGINAL TABLES** **ORIGINAL TABLES** **ORIGINAL TABLES** **ORIGINAL TABLES** **ORIGINAL TABLES** **ORIGINAL TABLES** **ORIGINAL TABLES**

Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation (as written)

	ESS Technology	**Aggregate Capacity[a]**	
		kWh	**MJ**
	Battery ESS		
1	Lead-acid, all types	70	252
2	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
3	Lithium-ion, all types	20	72
4	Sodium nickel chloride	20 (70[b])	72 (252[b])
5	Lithium metal	20	72
6	Nickel-hydrogen	20	72
7	Zinc bromide	20	72
8	Zinc manganese dioxide (Zn-MnO_2)	20	72
9	Flow batteries[c]	20	72
10	Iron-air and zinc-air	70	252
11	Other battery technologies	10	36
12	Batteries in one- and two-family dwellings and townhouse units	1	3.6
	Capacitor ESSs		
13	Electrochemical double layer capacitors[d]	3	10.8
14	Hybrid supercapacitors	20	72
	Other ESSs		
15	All other ESSs	70	252
16	Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Table 9.4.1 Maximum Stored Energy

	ESS Type	**Maximum Stored Energy[a] (kWh)**
1	Lead-acid batteries, all types	Unlimited
2	Nickel batteries[b]	Unlimited
3	Nickel-hydrogen batteries	Unlimited
4	Zinc manganese dioxide batteries (Zn-MnO_2)	600
5	Lithium-ion batteries, all types	600
6	Lithium metal batteries	600
7	Zinc bromide batteries	600
8	Sodium nickel chloride batteries	600
9	Flow batteries[c]	600
10	Iron-air and Zn-air batteries	600
11	Other battery technologies	200
12	Storage capacitors	20
13	Hybrid supercapacitors	600

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

		Compliance Required					
	Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
	Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
1	Lead-acid	Yes	Yes *	Yes *	Yes	Yes	Yes
2	Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes *	Yes *	Yes	Yes	Yes
3	Zing bromide	Yes	Yes *	Yes *	Yes	Yes	Yes
4	Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes *	Yes *	Yes	Yes	Yes
5	Nickel Hydrogen	No	No	No	No	Yes	Yes
6	Lithium-ion	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Flow	Yes	Yes	Yes	No	No	No
9	Sodium nickel chloride	No	No	No	No	Yes	Yes
10	Iron air	Yes	Yes	Yes	Yes	No	Yes
11	EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
12	Hybrid supercapacitor	No	No	No	No	No	No
13	Other electrochemical ESS and battery techologies +	Yes	Yes	Yes	Yes	Yes	Yes

* Applicable only to vented (e.g. flooded) batteries

\+ The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

END **END** **END** **END** **END** **END** **END** **END**

Public Comment No. 89-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]

This standard shall apply to ESS installations exceeding the values shown in Table 1.3 and the storage of lithium metal or lithium-ion batteries.

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

	Aggregate Capacity[a]	
ESSs Technology	kWh	MJ
Battery ESSs		-
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Sodium sulfur	70	252
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO_2)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		-
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		-
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Statement of Problem and Substantiation for Public Comment

Sodium Sulfur batteries are sold in container sizes, and the smallest size currently available has an energy capacity of 1450 kWh (container level). Each Cell has an energy capacity of 1.3kWh and each Module 245kWh. Threshold quantities similar to those given for Sodium Nickel Chloride technology, a technology very similar to Sodium Sulfur, can be used for Sodium Sulfur in the table. This cell and module are UL1973 listed and the cell performance meets UL9540A requirements.
The necessary documents can be found at the link: https://web.tresorit.com/l/SonJ0#lRHsZkJsbEu-m16bSfnEow

Related Item

- FR-3

Submitter Information Verification

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Submittal Date: Thu May 02 04:05:55 EDT 2024
Committee: ESS-AAA

Public Comment No. 325-NFPA 855-2024 [Section No. 1.4]

1.4 Retroactivity.

1.4.1

Unless otherwise specified, the provisions of this standard shall not apply to ESS installations that existed or were approved for construction or installation prior to the effective date of this standard. *{We are requesting additional clarification on what action(s) would remove the grandfather status provided by the retroactivity clause. For example, if a utility asset renews a station battery/batteries within a fire area that exceeds the limits imposed on Table 1.3 and was originally grandfathered in through the retroactivity clause, would that fire area then lose its grandfather status? What other actions on or around an ESS in a fire area would also qualify (expanding load centers, replacing the battery charger, etc)?}*

1.4.2*

In those cases where the authority having jurisdiction (AHJ) determines that an existing situation presents an unacceptable degree of risk, the AHJ shall be permitted to apply retroactively any portions of this standard deemed appropriate.

Statement of Problem and Substantiation for Public Comment

Provides additional clarity on the types of actions to a grandfathered ESS or fire area containing ESS(s) exceeding the limits imposed on Table 1 that would result in a revocation provided in the retroactivity clause.

Do "like-for-like" asset renewals simply not apply given the stated "approved for construction/installation prior to the effective date" verbiage provided?

Related Item

- FR-23

Submitter Information Verification

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Submittal Date: Thu May 30 15:28:52 EDT 2024
Committee: ESS-AAA

Public Comment No. 123-NFPA 855-2024 [Section No. 2.2]

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2024 edition.

NFPA 2, *Hydrogen Technologies Code*, 2023 edition.

NFPA 3, *Standard for Commissioning of Fire Protection and Life Safety Systems*, 2024 edition.

NFPA 4, *Standard for Integrated Fire Protection and Life Safety System Testing*, 2024 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2025 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2025 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2022 edition.

NFPA 22, Standard for Water Tanks for Private Fire Protection, 2023 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2025 edition.

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire protection Systems, 2020 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2024 edition.

NFPA 52, *Vehicular Natural Gas Fuel Systems Code*, 2023 edition.

NFPA 54, *National Fuel Gas Code*, 2024 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2024 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2024 edition.

NFPA 70®, *National Electrical Code*®, 2026 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*®, 2025 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*, 2024 edition.

NFPA 291, Recommended Practice for Fire Flow Testing and Marking of Hydrants, 2022 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards*, 2021 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2026 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.

NFPA 770, *Standard on Hybrid (Water and Inert Gas) Fire-Extinguishing Systems*, 2026 edition.

NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2020 edition.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems*, 2025 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Firefighting*, 2022 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2025 edition.

NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2025 edition.

Statement of Problem and Substantiation for Public Comment

Additional standards utilized for fire suppression, oil-insulated equipment seperation distance, and hydrants.

Related Item

- 116-NFPA 855-2023 [Section No. 2.2

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Committee:	ESS-AAA

Public Comment No. 124-NFPA 855-2024 [Section No. 2.3.7]

2.3.7 IEEE Publications.

IEEE, 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE C2, *National Electrical Safety Code*, 2017.

IEEE 979, Guide for Substation Fire Protection, 2012.

IEEE 1635/ASHRAE 21, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*, 2022.

IEEE 2030.2.1 Guide for the Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Application Integrated with Electric Power Systems, 2019.

Statement of Problem and Substantiation for Public Comment

Additional relevant IEEE standards

Related Item

- First Revision No. 200-NFPA 855-2023 [Section No. 2.3.5

Submitter Information Verification

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Submittal Date: Wed May 22 16:28:20 EDT 2024
Committee: ESS-AAA

Public Comment No. 247-NFPA 855-2024 [Section No. 2.3.9]

2.3.9 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 263, *Fire Tests of Building Construction and Materials*, 2011.

UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018.

UL 991, Standard for Tests for Safety-Related Controls Employing Solid-State Devices

UL 1012, *Power Units Other Than Class 2*, 2010.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021.

UL 1778, *Uninterruptible Power Systems*, 2014.

UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* 2022.

CAN/UL 1974, *Evaluation for Repurposing Batteries*, 2018.

UL 1998, Software in Programmable Components

CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

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

UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019.

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2021.

Statement of Problem and Substantiation for Public Comment

Additional standards need in reference to listing requirements of components to 9540.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 246-NFPA 855-2024 [Section No. 4.6.1]	
Public Comment No. 248-NFPA 855-2024 [New Section after 3.3]	

Related Item

- CI 182

Submitter Information Verification

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Submittal Date: Wed May 29 11:53:44 EDT 2024

Committee: ESS-AAA

Public Comment No. 329-NFPA 855-2024 [Section No. 2.3.9]

2.3.9 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 263, *Fire Tests of Building Construction and Materials*, 2011.

UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018.

UL 1012, *Power Units Other Than Class 2*, 2010.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021.

UL 1778, *Uninterruptible Power Systems*, 2014.

CAN/ UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications*, 2022.

CAN/UL 1974, *Evaluation for Repurposing Batteries*, 2018.

CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

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

CAN/UL 9540B, Outline of Investigation for Large Scale Fire Test for Residential Battery Energy Storage Systems, 2024.

UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019.

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2021.

Statement of Problem and Substantiation for Public Comment

Updated UL references that have changed since the first draft references were approved as a first revision. Added UL 9540B for consideration if resolved as a related item to PC 95.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 332-NFPA 855-2024 [Section No. H.1.2.13]	

Related Item

- • FR-34 • PC-95

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Committee: ESS-AAA

Public Comment No. 96-NFPA 855-2024 [Section No. 2.3.9]

2.3.9 UL Publications.

~~Underwriters Laboratories~~ ULSE Inc., ~~333 Pfingsten Road, Northbrook~~ 1603 Orrington Avenue, Evanston , IL ~~60062-2096~~ 60201 .

UL 263, *Fire Tests of Building Construction and Materials*, 2011, revised 2022 .

UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, ~~2018~~ 2022 .

UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021 .

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021, revised 2023 .

UL 1778, *Uninterruptible Power Systems*, 2014, revised 2024 .

ANSI/CAN/ UL 1973, *Batteries for Use in ~~Stationary, Vehicle~~ S tationary and Motive Auxiliary Power ~~and Light Electric Rail (LER)~~ Applications, 2022.*

ANSI/ CAN/UL 1974, Evaluation for ~~Repurposing~~ Repurposing or Remanufacturing Batteries, ~~2018~~ 2023 .

ANSI/ CAN/UL 9540, Energy Storage Systems and Equipment, 2023.

ANSI/CAN/ UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019.

UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.

UL 62368-1, Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements, 2019, revised 2021.

UL Solutions Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 9540B, Outline of Investigation for Large-scale Fire Test for Residential Battery Energy Storage Systems, 2024.

Statement of Problem and Substantiation for Public Comment

Update UL standard issue dates and revision dates; update standard titles.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 280-NFPA 855-2024 [Section No. H.1.2.13]	

Related Item

- FR-116

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Committee:	ESS-AAA

Public Comment No. 111-NFPA 855-2024 [New Section after 3.3]

3.3.40 Battery Analytics Software.

A cloud-based software solution using lithium-ion ESS raw data collected by the Battery Management System (BMS) and applies physics-based algorithms to offer immediate and predictive detection (on the order of weeks and months) of thermal runaway and its associated root causes.

Statement of Problem and Substantiation for Public Comment

There are numerous Battery Analytics Software providers (Accure, Elysia, Peaxy, PowerUp, Twaice, Volytica, among others) available on the market today. They have developed algorithms through electrochemical testing to develop the predictive capabilities mentnioned in the definition. All of these companies have produce Battery Analytics Software that complies with the definition as it is currently proposed, allowing ESS stakeholders to choose from a variety of vendors to meet the standard.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 107-NFPA 855-2024 [New Section after 9.2.1.1]	PI 248
Public Comment No. 108-NFPA 855-2024 [New Section after 9.2.2]	PI 248
Public Comment No. 110-NFPA 855-2024 [Section No. 4.4.4]	PI 248
Public Comment No. 112-NFPA 855-2024 [Section No. 9.2.1.1]	

Related Item

- PI 248

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Committee:	ESS-AAA

Public Comment No. 158-NFPA 855-2024 [New Section after 3.3]

Large-scale fire test

A test that involves igniting and burning an ESS enclosure and its contents until they are fully consumed.

Statement of Problem and Substantiation for Public Comment

This adds a placeholder definition for large-scale fire testing that is referenced in Chapter 9. Task Group 9 Explosions is working on various aspects related to fire testing.

Related Item

- 9.1.5.1

Submitter Information Verification

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Submittal Date: Fri May 24 15:49:30 EDT 2024
Committee: ESS-AAA

Public Comment No. 248-NFPA 855-2024 [New Section after 3.3]

3.3.X DC Energy Storage System (DC ESS).

A productized system made up of an enclosure, battery system, Critical Safety Systems and communications required to product the battery system and designed for direct interconnection with PCS and ESMS systems.

Statement of Problem and Substantiation for Public Comment

With alternate methods of construction and fabrication such as Buildings, final assembly on site, supply chain aggregation, and other technologies that may not lend themselves to completion in the factory such as flow batteries, a 9540 listing at the factory may not be feasibly or even possible. This provides a option for meeting the compliance criteria of 9540 with out lessening the standard. Definition that allows Decoupling of 9540 from other core listings.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 247-NFPA 855-2024 [Section No. 2.3.9]	

Related Item

- CI 182

Submitter Information Verification

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Submittal Date: Wed May 29 11:56:51 EDT 2024
Committee: ESS-AAA

Public Comment No. 3-NFPA 855-2024 [New Section after 3.3.10]

TITLE OF NEW CONTENT

3.3.X Emergency Power Supply (EPS)

The source of electric power of the required capacity and quality for an emergency power supply system (EPSS). [110, 2022]

Statement of Problem and Substantiation for Public Comment

FR-190 created the new definition Emergency Power Supply System (EPSS) and uses the acronym EPS which is not defined in this document. Adding this definition would now define this acronym EPS as it applies to this document. This definition of Emergency Power Supply (EPS) was also extracted from NFPA 110 (2022).

Related Item

- FR-190

Submitter Information Verification

Submitter Full Name:	Darryl Hill
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Submittal Date:	Fri Mar 08 11:49:21 EST 2024
Committee:	ESS-AAA

Public Comment No. 244-NFPA 855-2024 [Section No. 3.3.12]

3.3.12* Energy Storage ~~System Limited-Production Certification (LPC)~~ System Certification .

A process that enables system integrators or original equipment manufacturers may have to field ~~assemble~~ assembly , ~~test~~ testing , ~~commission, and~~ and commissioning in there fabrication process to certify energy storage systems ~~as satisfying the~~ satisfies the requirements of the appropriate test standard (9540) .

A.3.3.12 For Purposes of NFPA 855 this would include UL 9540. Due to supply chain management, not all equipment may be fabricated in one production facility. Some final fabrication may be finalized in the field. This may be referred to as the field evaluation compont. The certification will require both factory certification as well as field evaluation. UL 1973 or other listings will provide some of the factory certification as required by 9540. A LPC or a Field evaluation are not acceptable or a replacement for UL 9540 listing.

Statement of Problem and Substantiation for Public Comment

Due to fabrications, one off, or supply chains, final integration may be at site. A certification (not a LPC) that meets all requirements on UL 9540 may be acceptable.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 242-NFPA 855-2024 [Section No. 3.3.14]	
Public Comment No. 245-NFPA 855-2024 [New Section after 4.6.1]	

Related Item

- FR 50

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Wed May 29 10:55:38 EDT 2024
Committee: ESS-AAA

Public Comment No. 148-NFPA 855-2024 [Section No. 3.3.13.2]

~~**3.3.13.2** * – Critical Safety Component or System.~~

~~A component or system designed to prevent loss of life, serious personal injury, or damage to the natural environment.~~

Statement of Problem and Substantiation for Public Comment

Critical Safety Systems definition in 3.3.13.2 is a duplication of 3.3.6 and should be removed.

Related Item

- FR 193 • FR 198

Submitter Information Verification

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Submittal Date: Fri May 24 13:53:28 EDT 2024
Committee: ESS-AAA

Public Comment No. 56-NFPA 855-2024 [Section No. 3.3.13.2]

~~**3.3.13.2** * – Critical Safety Component or System.~~

~~A component or system designed to prevent loss of life, serious personal injury, or damage to the natural environment.~~

Statement of Problem and Substantiation for Public Comment

This definition is repeated and out of place. It can be removed.

Related Item

- FR-198

Submitter Information Verification

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Submittal Date:	Fri Mar 15 10:20:19 EDT 2024
Committee:	ESS-AAA

Public Comment No. 67-NFPA 855-2024 [New Section after 3.3.13.10]

NEW DEFINITION

-

3.3.XX* Traditional Standby Power Application. An energy storage system that is not grid interactive and utilizes a flooded lead-acid or nickel-cadmium battery, less than 600 Vdc, that is intended to remain on continuous float charge in a high state of charge to support an event necessitating a discharge.

*Annex: Traditional standby power applications are commonly communications utility standby power, electric utility standby power for control of substations and control or shutdown of generating stations, control of fixed guideway transit or passenger rail systems, and some UPS systems comprised of flooded lead-acid cells. Traditional standby power applications are normally intended to provide power to local loads for some period of time in the event of a commercial power failure. The batteries in these applications are characterized by long service life, low propensity for fire spread, and are not typically subjected to UL listing.

Statement of Problem and Substantiation for Public Comment

It would be helpful to have a definition for traditional standby ESS plants and later use this in the exemption wording in the body of the standard. This would help to make the wording in the lead-acid "carve-outs" more uniform and simplified.

Related Item

- FR-125 and other edits to lead-acid carve outs

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Tue Mar 19 17:24:51 EDT 2024
Committee: ESS-AAA

Public Comment No. 242-NFPA 855-2024 [Section No. 3.3.14]

3.3.14* Field Evaluation.

~~An evaluation based on an appropriate test standard to verify the failure of structures, systems, or components do not result in fire, electrical shock, or injury of personnel~~ Part of the certification process that is completed after the equipment has left the fabrication facility in order to complete the 9540 requirements based on final aggregation of ESS equipment at the construction site .

Statement of Problem and Substantiation for Public Comment

Due to fabrications, one off, or supply chains, final integration may be at site. the Field evaluation may be a component of 9540 listing but doesn't replace 9540 even for certification.

Related Public Comments for This Document

Related Comment	**Relationship**
Public Comment No. 243-NFPA 855-2024 [Section No. A.3.3.14]	
Public Comment No. 244-NFPA 855-2024 [Section No. 3.3.12]	
Public Comment No. 245-NFPA 855-2024 [New Section after 4.6.1]	
Public Comment No. 246-NFPA 855-2024 [Section No. 4.6.1]	

Related Item

• FR 52 • CI 182

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Submittal Date:	Wed May 29 10:35:00 EDT 2024
Committee:	ESS-AAA

Public Comment No. 145-NFPA 855-2024 [Section No. 3.3.15]

3.3.15 Fire and Explosion Testing.

Testing of a representative energy storage system that evaluates the fire and explosion hazards produced ~~by a propagating thermal~~ by thermal runaway propagation .

Statement of Problem and Substantiation for Public Comment

The requirement changes to 9.1.5.1 of adding "large scale Fire test" in addition to 9540A, the term for propagation is critical to understanding the data collected. A definition of Thermal runaway propagation is added due to the changes required in 9.1.5.1, so this change aligns with the defined term.

Related Item

- PI 139

Submitter Information Verification

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Submittal Date: Fri May 24 10:21:23 EDT 2024
Committee: ESS-AAA

Public Comment No. 1-NFPA 855-2024 [Section No. 3.3.21]

3.3. ~~21~~ XX Gas

3.3.XX.1 Highly Toxic Gas.

A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2023]

Additional Proposed Changes

File Name	Description	Approved
855_definition_Gas.docx	Definition for Gas	

Statement of Problem and Substantiation for Public Comment

The new terms Highly Toxic Gas and Toxic Gas that are now defined in Chapter 3 should be defined together under the common definition title of "Gas" as they are defined in NFPA 55 where both terms were extracted from. This would help with usability by keeping the terms together and keep them consistent with the other document. Also if any other terms related to "Gas" needed to be defined in the future they could be placed under this title.
See included Word doc for intended layout of the terms.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 2-NFPA 855-2024 [Section No. 3.3.38]	
Public Comment No. 2-NFPA 855-2024 [Section No. 3.3.38]	

Related Item

- FR No. 82 and PI No. 32

Submitter Information Verification

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Submittal Date:	Thu Mar 07 14:21:27 EST 2024
Committee:	ESS-AAA

3.3.XX Gas.

3.3.XX.1 Highly Toxic Gas.

A chemical that has a median lethal concentration (LC_{50}) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each.

3.3.XX.2 Toxic Gas.

A gas with a median lethal concentration (LC_{50}) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each.

Public Comment No. 217-NFPA 855-2024 [Section No. 3.3.21]

3.3.21* Highly Toxic Gas.

A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2023]

A.3.3.21 An example of a highly toxic gas would be Hydrogen Cyanide (HCN) which has a reported LC_{50} (1-hour) of 139 ppm (Nemours 1981).

Statement of Problem and Substantiation for Public Comment

Added clarification to what would be considered a Highly Toxic gas, TG 6

Related Item

- FR 82

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Tue May 28 10:05:47 EDT 2024
Committee: ESS-AAA

Public Comment No. 68-NFPA 855-2024 [New Section after 3.3.22]

Commentary on CI-83,

Almost any fire can have toxic emissions and electric vehicle fires have many of these same challenges. The definitions seem reasonable but I feel the topic is so broad that it is outside the scope of an installation standard.

Statement of Problem and Substantiation for Public Comment

As stated.

Related Item

- CI-83, 84, 85

Submitter Information Verification

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Submittal Date: Thu Mar 21 16:24:11 EDT 2024
Committee: ESS-AAA

Public Comment No. 79-NFPA 855-2024 [New Section after 3.3.36]

TITLE OF NEW CONTENT

Type your content here ..

3.3.37 **Thermal Runaway Protection System - A primary or supplemental system for managing the thermal condition of lithium ion batteries.**

Additional Proposed Changes

File Name	**Description**	**Approved**
Thermal_management_of_the_103_Ah_-_36_cell_module.jpg	Direct injection of a fluid for thermal management of an event	
Free_burn_103_Ah_-_36_cell_module.jpg	Free burn of the same module in which a failure was initiated.	

Statement of Problem and Substantiation for Public Comment

There are systems utilized that are specifically designed to control thermal runaway events. NFPA 855 does not currently reference these systems. This text will recognize these systems and this will help approval agencies like UL develop standards to support them.

Related Item

- FR-45

Submitter Information Verification

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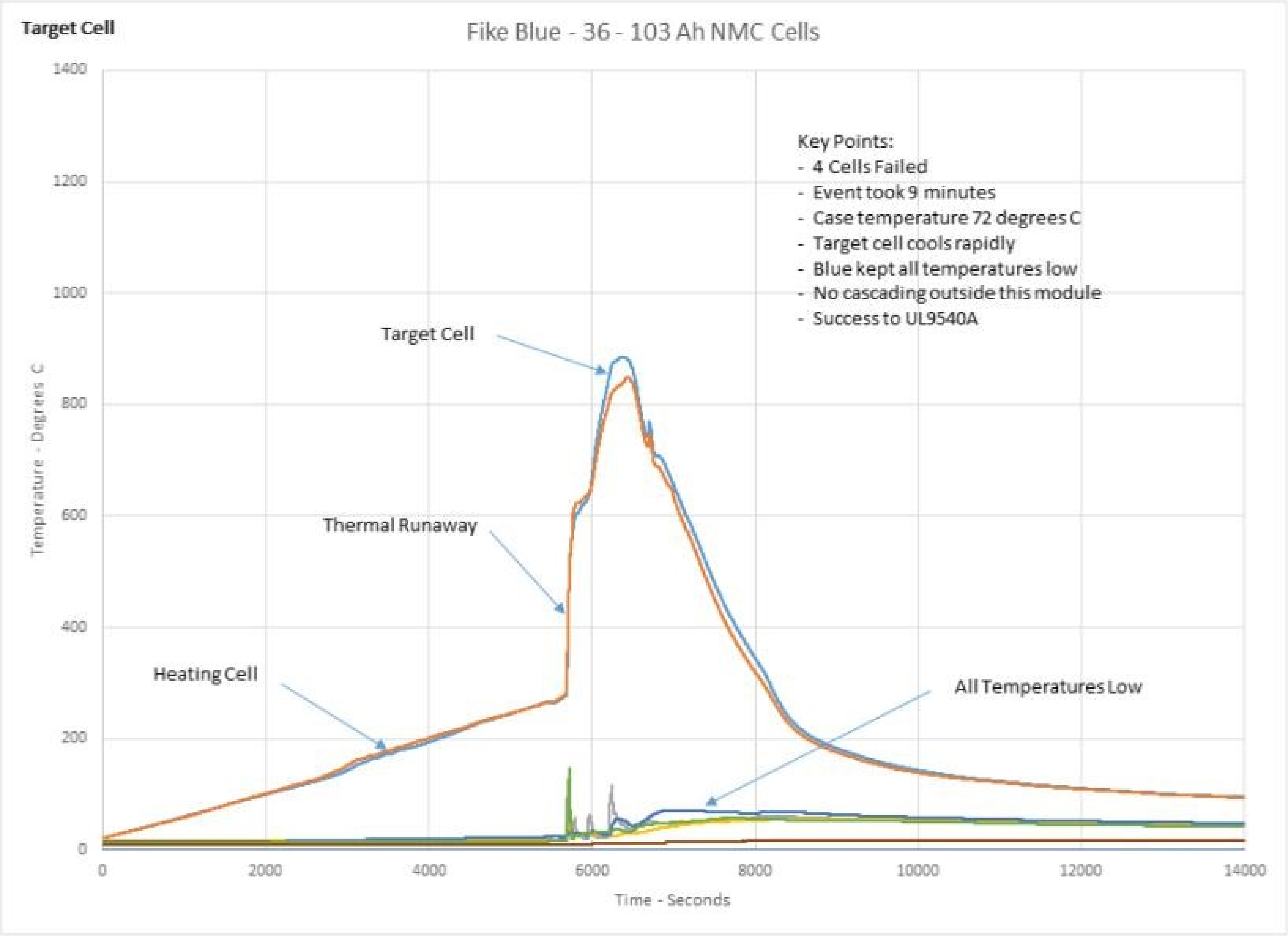
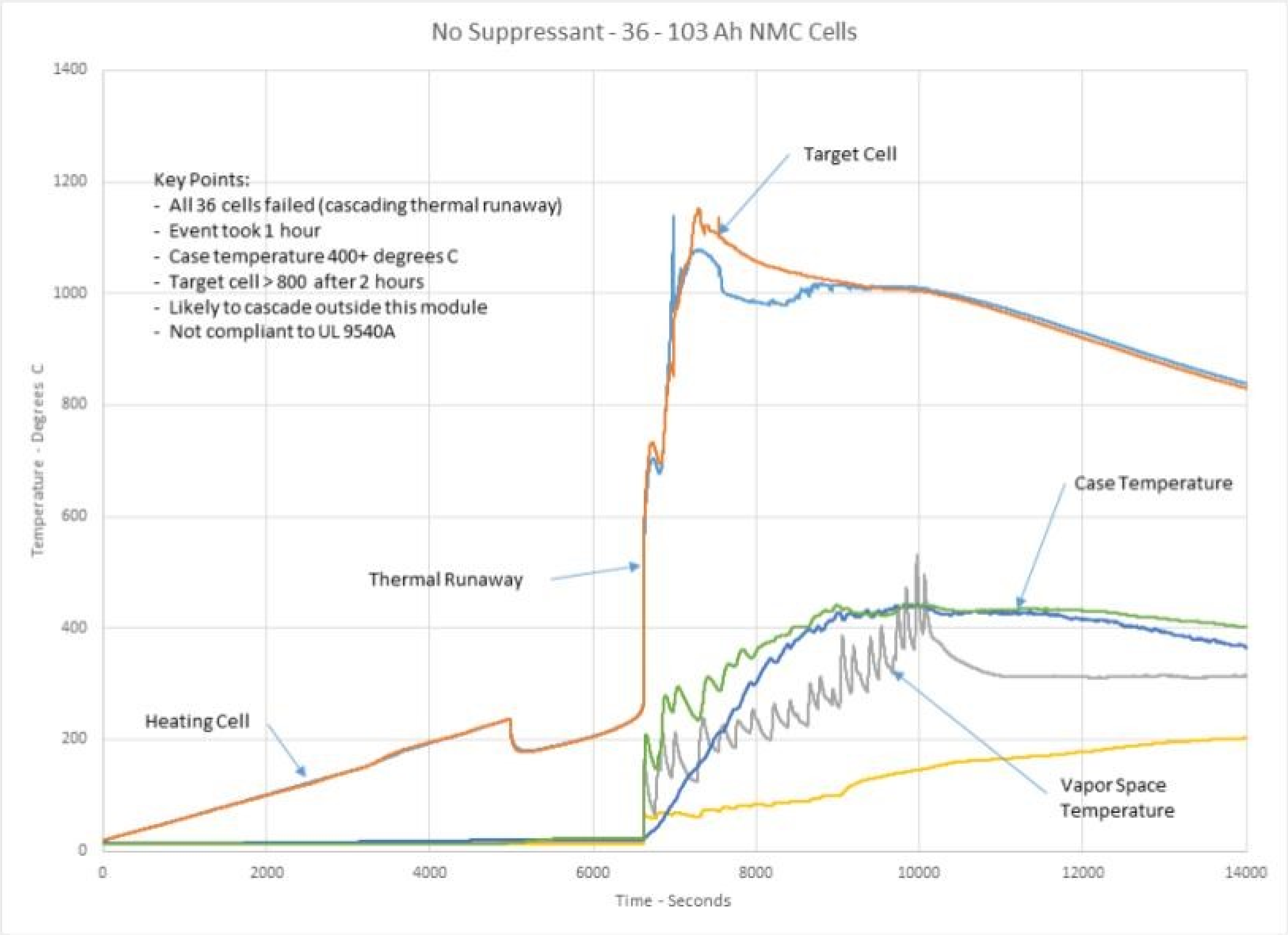
Submittal Date: Tue Apr 02 13:33:26 EDT 2024
Committee: ESS-AAA



Key Points:
- 4 Cells Failed
- Event took 9 minutes
- Case temperature 72 degrees C
- Target cell cools rapidly
- Blue kept all temperatures low
- No cascading outside this module
- Success to UL9540A



Key Points:
- All 36 cells failed (cascading thermal runaway)
- Event took 1 hour
- Case temperature 400+ degrees C
- Target cell > 800 after 2 hours
- Likely to cascade outside this module
- Not compliant to UL 9540A

Public Comment No. 256-NFPA 855-2024 [Section No. 3.3.37]

~~3.3.37~~ ~~*~~ ~~– Thermal Walkaway.~~

~~A slow heating process driven by an external current source and caused by abuse, neglect, or internal cell failure that results in overheating and increased gas production.~~

Statement of Problem and Substantiation for Public Comment

Form Energy does not support the creation of the term “thermal walkaway”. As the condition is described in A.3.3.37, this is an overcharge failure and as such, is an entirely separate failure mode from thermal runaway. The term thermal walkway is misleading and may result in more confusion.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 257-NFPA 855-2024 [Section No. A.3.3.37]	

Related Item

- FR-42

Submitter Information Verification

Submitter Full Name: Alli Nansel
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Submittal Date: Wed May 29 14:16:19 EDT 2024
Committee: ESS-AAA

Public Comment No. 2-NFPA 855-2024 [Section No. 3.3.38]

3.3. ~~38~~ XX Gas

3.3.XX.2 Toxic Gas.

A gas with a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2023]

Additional Proposed Changes

File Name	**Description**	**Approved**
855_definition_Gas.docx	Definition for Gas	

Statement of Problem and Substantiation for Public Comment

The new terms Highly Toxic Gas and Toxic Gas that are now defined in Chapter 3 should be defined together under the common definition title of "Gas" as they are defined in NFPA 55 where both terms were extracted from. This would help with usability by keeping the terms together and keep them consistent with the other document. Also if any other terms related to "Gas" needed to be defined in the future they could be placed under this title.
See included Word doc for intended layout of the terms.

Related Public Comments for This Document

Related Comment	**Relationship**
Public Comment No. 1-NFPA 855-2024 [Section No. 3.3.21]	
Public Comment No. 1-NFPA 855-2024 [Section No. 3.3.21]	

Related Item

- FR No. 81 and PI No. 31

Submitter Information Verification

Submitter Full Name: Darryl Hill
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Submittal Date: Thu Mar 07 16:07:37 EST 2024
Committee: ESS-AAA

3.3.XX Gas.

3.3.XX.1 Highly Toxic Gas.

A chemical that has a median lethal concentration (LC_{50}) in air of 200 ppm by volume or less of gas or vapor, or 2 mg/L or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each.

3.3.XX.2 Toxic Gas.

A gas with a median lethal concentration (LC_{50}) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each.

Public Comment No. 216-NFPA 855-2024 [Section No. 3.3.38]

3.3.38* Toxic Gas.

A gas with a median lethal concentration (LC50) in air of more than 200 ppm but not more than 2000 ppm by volume of gas or vapor, or more than 2 mg/L but not more than 20 mg/L of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 0.44 lb and 0.66 lb (200 g and 300 g) each. [**55,** 2023]

A.3.3.38 An example of a toxic gas would be Hydrogen Fluoride (HF) which has a reported LC_{50} (1-hour) of 1276 ppm (Darmer, 1972).

Statement of Problem and Substantiation for Public Comment

needed clarification of types of gases that would be Toxic. TG 6

Related Item

- FR 81

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Street Address:
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Submittal Date: Tue May 28 10:03:02 EDT 2024
Committee: ESS-AAA

Public Comment No. 144-NFPA 855-2024 [New Section after 3.3.39]

3.3.xx THERMAL RUNAWAY PROPAGATION – The transfer of thermal energy released from one or more cells undergoing thermal runaway that leads to thermal runaway of non-adjacent cells without any additional initiating mechanism(s).

Statement of Problem and Substantiation for Public Comment

The term Propagation is used extensively thru out 855 and the requirements of UL 9540A. However it is not a defined term and can be used in different way. UL is adding this definition to 9540.

Additionally with the requirement changes to 9.1.5.1 of adding "large scale Fire test" in addition to 9540A, the term for propagation is critical to understanding the data collected. Current codes state "fire" shall not propagate to adjacent containers with not clear level of impact. Any fire would constitute a failure during a test. TRP is a more appropriate level of evaluation and not constrained to an absolute of only "fire".

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 194-NFPA 855-2024 [Section No. 9.1.5]	

Related Item

- PI 139

Submitter Information Verification

Submitter Full Name: Paul Hayes
Organization: The Hiller Companies/American
Street Address:
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Submittal Date: Fri May 24 10:10:34 EDT 2024
Committee: ESS-AAA

Public Comment No. 146-NFPA 855-2024 [New Section after 3.3.39]

> **3.3. Large Scale Fire Testing - Testing of a battery energy storage system by initiating a propagating fire condition within the unit of origin, involving but not limited to batteries, and observing the effects on surrounding exposures that can lead to involvement of surrounding combustibles.**

Statement of Problem and Substantiation for Public Comment

The changes to 9.1.5.1 of adding "large scale Fire test" in addition to 9540A, the term for Large Scale fire testing is a specific test and different that fire and explosion testing. Modification to UL and 855 are aligning on what constitutes a large scale test under 9.1.5.1 as such the definition is the first step on this alignment.

Related Public Comments for This Document

Related Comment	**Relationship**
Public Comment No. 194-NFPA 855-2024 [Section No. 9.1.5]	

Related Item

- PI 139

Submitter Information Verification

Submitter Full Name:	Paul Hayes
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Submittal Date:	Fri May 24 10:29:17 EDT 2024
Committee:	ESS-AAA

Public Comment No. 149-NFPA 855-2024 [New Section after 3.3.39]

3.3.XX* Survivability

The ability of a system, equipment, process or procedure to continue performing its intended function during a failure condition.

A.3.3.XX Survivability

Critical safety systems shall be capable of surviving a unit or installation level failure condition up until the point of catastrophic failure due to fire. Data gathered from unit or installation level UL9540A or large-scale testing should be used to determine probability and scale of a unit or installation level failure. A functional safety analysis should be performed to ensure that the critical safety systems and components are designed and installed to meet the duration up to catastrophic failure due to fire.

Statement of Problem and Substantiation for Public Comment

The term survivability is added to the requirements of explosion and power chapter updates and is not defined. This provides a definition.

Related Item

- FR 192

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Fri May 24 13:57:47 EDT 2024
Committee: ESS-AAA

Public Comment No. 83-NFPA 855-2024 [New Section after 3.3.39]

3.3.X* Failure Modes and Effects Analysis (FMEA)

- **"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the End user, and can be potential or actual.**
- **"Effects analysis" refers to studying the consequences of those failures.**

A.3.3.X Failures are prioritized according to how serious their consequences are, how frequently they occur, and how easily they can be detected. It is used during design to help mitigate against failures. It is to take actions to eliminate or reduce failures, starting with the highest-priority ones. It begins during the earliest conceptual stages of design and continues throughout the life of the BESS products and services.

-

Statement of Problem and Substantiation for Public Comment

This Definition is used 5+ time in the code but is not defined. It was submitted by Task Group 4 and approved in committee but never balloted. Resubmitting for approval.

Related Item

- PI 65

Submitter Information Verification

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Submittal Date: Sat Apr 20 15:26:30 EDT 2024
Committee: ESS-AAA

Public Comment No. 5-NFPA 855-2024 [Section No. 4.2.1.1]

4.2.1.1

The plans and specifications associated with an ESS and its intended installation, replacement or renewal, commissioning, and use shall be submitted to the AHJ for approval and include the following:

(1) Location and layout diagram of the room or area in which the ESS is to be installed

(2) Details on hourly fire-resistant-rated assemblies provided or relied upon in relation to the ESS

(3) The quantities and types of ESS units

(4) Manufacturer's specifications, ratings, and listings of ESSs

(5) Description of energy storage management systems and their operation

(6) Location and content of required signage

(7) Details on fire suppression, smoke or fire detection, gas detection, thermal management, ventilation, exhaust, and ~~deflagration venting systems~~ explosion prevention systems , if provided

(8) Support arrangement associated with the installation, including any required seismic support

Statement of Problem and Substantiation for Public Comment

Edits in the first draft to section 9.6.6.6.3 identify these systems as explosion prevention systems. It would be good to use this terminology consistently.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 6-NFPA 855-2024 [Section No. 4.2.1.1]	

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Tue Mar 12 12:46:54 EDT 2024
Committee: ESS-AAA

Public Comment No. 6-NFPA 855-2024 [Section No. 4.2.1.1]

4.2.1.1

The plans and specifications associated with an ESS and its intended installation, replacement or renewal, commissioning, and use shall be submitted to the AHJ for approval and include the following:

(1) Location and layout diagram of the room or area in which the ESS is to be installed

(2) Details on hourly fire-resistant-rated assemblies provided or relied upon in relation to the ESS

(3) The quantities and types of ESS units

(4) Manufacturer's specifications, ratings, and listings of ESSs

(5) Description of energy storage management systems and their operation

(6) Location and content of required signage

(7) Details on fire suppression, smoke or fire detection, gas detection, thermal management, ventilation, exhaust, and ~~deflagration venting~~ explosion prevention systems, if provided

(8) Support arrangement associated with the installation, including any required seismic support

Statement of Problem and Substantiation for Public Comment

Edits in the first draft to 9.6.6.6. identify these systems as explosion prevention systems. It would be good to use this terminology consistently. Also prevention is a better result than control.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 5-NFPA 855-2024 [Section No. 4.2.1.1]	Same issue

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: ATIS
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Submittal Date: Tue Mar 12 12:52:59 EDT 2024
Committee: ESS-AAA

Public Comment No. 97-NFPA 855-2024 [Section No. 4.3]

4.3 Emergency Planning and Training.

4.3.1* General.

For ESS installations, emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations and maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.

4.3.2 Facility Staff Planning and Training.

For ESS installations, an emergency operations plan and associated training shall be established, maintained, and conducted by ESS facility operations and maintenance personnel.

4.3.2.1 Emergency Operations Plan.

4.3.2.1.1

An emergency operations plan shall be readily available for use by facility operations and maintenance personnel.

4.3.2.1.2

The emergency operations plan shall be on site in an approved location or available digitally where approved.

4.3.2.1.3

The plan shall be updated when conditions that affect the response considerations and procedures change.

4.3.2.1.4

The emergency operations plan shall include the following:

(1) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries

(2) Procedures for inspection and testing of associated alarms, interlocks, and controls

(3)* Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required

(4)* Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions

(5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required

(6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility

(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders

(8) Procedures and schedules for conducting drills of these procedures

4.3.2. 1.5 Lead acid or nickel cadmium battery systems that are used for traditional standby power applications under the exclusive control of a communications utility located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.3. 2 .1.

4.3.2.1.6 Facility Staff Training.

4.3.2.~~2~~ 1 .6. 1–

Personnel responsible for the installation of the ESS shall be trained in the procedures included in the emergency operations plan in 4.3.2.1 prior to the ESS arriving onsite.

4.3.2.~~2~~ 1 .6. 2–

Personnel responsible for the operation, maintenance, and repair of the ESS shall be trained in the procedures included in the emergency operations plan in 4.3.2.1 prior to the commissioning of the ESS.

4.3.2.~~2~~ 1 .6. 3

Refresher training shall be conducted at least annually and records of such training retained in an approved manner.

4.3.3 Emergency Response Plan.

4.3.3.1 General.

For ESS installations, an emergency response plan and associated training shall be established, maintained, and conducted so that ESS facility operations personnel and emergency responders can address foreseeable hazards associated with the on-site emergencies.

4.3.3.2 Emergency Response Plan.

4.3.3.2.1

The emergency response plan shall be in accordance with Chapters 17 through 23 of NFPA 1660.

4.3.3.2.2

The emergency response plan shall, at a minimum, address the following:

(1) Mitigation

(2) Preparedness

(3) Response

(4) Recovery

4.3.3. 2.3 Lead acid or nickel cadmium battery systems that are used for traditional standby power applications under the exclusive control of a communications utility located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4. 3 .3.2.

4.3.3.2.4 Training.

4.3.3.~~3~~ 2 .4. 1

Personnel responsible for the installation of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the ESS arriving onsite.

4.3.3.~~3~~ 2 .4. 2–

Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the commissioning of the ESS.

4.3.3.2. 4.3 Refresher Training.

4.3.3.2. 4.~~1~~ 4

Refresher training shall be conducted by ESS facility operations personnel at least annually.

4.3.3.2. 4.~~2~~ 5

Records of such training shall be retained in an approved manner.

4.3.3.~~5~~ 2.4.6 Notification.

Emergency responders shall be notified of the training dates and locations.

Statement of Problem and Substantiation for Public Comment

Consider an exemption for the emergency operations and emergency response plans for traditional standby power applications for telecom utilities. These entities are already highly regulated by both PUCs and the FCC with respect to backup power requirements and reliability. They have been safely using these older chemistries across 100,000 sites for many decades without fire or electrical hazards that would justify an NFPA 855 mandated Emergency Operations Plan or Emergency Operations Plan.

Consider changes to the heading numbers to move the training under the heading of the plans are all training is on the corresponding operations and response plans.

Related Item

- FR-15

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Wed May 08 10:02:27 EDT 2024
Committee: ESS-AAA

Public Comment No. 169-NFPA 855-2024 [Section No. 4.3.1]

4.3.1* General.

~~For ESS installations, emergency~~ ESS emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations ~~and maintenance~~ , maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.

Statement of Problem and Substantiation for Public Comment

Remove the word "For" at the start of this requirement as it is not needed after FR-15 deleted the language that was previously in this requirement. Delete the word "installations" as this is redundant. Lastly delete the "and" after operations and replace it with a coma for better usability. Note Terra shows maintenance deleted and then added again and was not part of this comment.

Related Item

- FR-15

Submitter Information Verification

Submitter Full Name: Darryl Hill

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Submittal Date: Sun May 26 13:28:44 EDT 2024

Committee: ESS-AAA

Public Comment No. 7-NFPA 855-2024 [Section No. 4.3.1]

4.3.1* General.

For ESS installations ~~, emergency~~ exceeding the values shown in table 4.3.1, emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations and maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.

Table 4.3.1 Quantities per Each Fire Area or Outdoor Installation for Determination of Emergency Planning and Training

	Aggregate Capacity	
ESS Technology	kWh	MJ
Battery ESS		
Lead-acid, all types	350	1260
Ni-Cd, Ni-MH, and NiZn	350	1260
Lithium-ion, all types	100	360
Sodium-nickel chloride	350	126
Flow batteries	100	360
Other battery technologies	50	180
Capacitor ESS	10	36
Flywheel ESS	25	90
All other ESS	70	252

Additional Proposed Changes

File Name	**Description**	**Approved**
Draft_of_Table_4.3.1.docx	Table in word format in case Terraview misbehaves.	

Statement of Problem and Substantiation for Public Comment

The threshold ESS energy levels dictating the need for Emergency Planning and Training were increased in the 2023 edition. The Committee statement justifying this change was:

The requirement to have emergency training and an operations plan seems excessive for the deployment [of] commercial products that are deployed in accordance with this standard and used consistent with their listing. For larger commercial or utility scale sites with dedicated maintenance staff the requirement is proper, but it seems excessive for smaller sites that are not dedicated ESS installations. An example of the latter could be a UPS system in a commercial facility that is just over the thresholds of Table 1.3. For systems such as these, understanding and following the operations and maintenance manual, as provided by the manufacturer, should be sufficient. Installations exceeding Table 4.8 [MSE values] are considered higher hazards and would warrant the training and operations plan as described.

I agree with the position that Emergency Planning and Training for installations below the Maximum Stored Energy Limits are warranted, but I feel a threshold between the table 1.3 values and the Maximum Stored Energy Limits makes the most sense and is consistent with the Technical

Committees action in the 2023 edition. A set of limits below the MSE at roughly 5x the table 1.3 values are suggested as a starting point.

Note further, that for all ESS, Section 7.1.2 under Operation and Maintenance already requires in listed item (4) Response considerations similar to safety data sheets (SDS) that address response safety concerns and extinguishment where SDS in not required. So even for very small installations, there is already a requirement to have response guidance available.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 8-NFPA 855-2024 [Section No. 4.3.2 [Excluding any Sub-Sections]]	
Public Comment No. 9-NFPA 855-2024 [Section No. 4.3.3]	

Related Item

- FR-15

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Zip:	
Submittal Date:	Tue Mar 12 12:56:16 EDT 2024
Committee:	ESS-AAA

Table 4.3.1 Quantities per Each Fire Area or Outdoor Installation for Determination of Emergency Planning and Training

	Aggregate Capacity	
ESS Technology	kWh	MJ
Battery ESS		
Lead-acid, all types	350	1260
Ni-Cd, Ni-MH, and NiZn	350	1260
Lithium-ion, all types	100	360
Sodium-nickel chloride	350	126
Flow batteries	100	360
Other battery technologies	50	180
Capacitor ESS	10	36
Flywheel ESS	25	90
All other ESS	70	252

Public Comment No. 98-NFPA 855-2024 [Section No. 4.3.1]

4.3.1* General.

For ESS installations, emergency planning and training shall be provided by the owner of the ESS or their authorized representative so that ESS facility operations and maintenance personnel and emergency responders can address foreseeable hazards associated with the on-site systems.

4.3.2 Lead acid or nickel cadmium battery systems that are UL 1973 listed or are used solely for traditional standby power applications shall not be required to comply with section 4.3.

Statement of Problem and Substantiation for Public Comment

Recommend an exemption for traditional standby power applications from Emergency Response and Emergency Operations Plans and training. These systems have not required these in the past issue of NFPA 855 and no data has been presented to warrant these going forward.

New proposed definition for Traditional Standby Power Application is An energy storage system that is not grid interactive and utilizes a flooded lead-acid or nickel-cadmium battery, less than 600 Vdc, that is intended to remain on continuous float charge on in a high state of charge to support an event necessitating a discharge.

*Annex: Traditional standby power applications are commonly communications utility standby power, electric utility standby power for control of substations and control or shutdown of generating stations, and some UPS systems comprised of flooded lead-acid cells. Traditional standby power applications are normally intended to provide power to local loads for some period of time in the event of a commercial power failure. The batteries in these applications are characterized by long service life, low propensity for fire spread, and are not typically subjected to UL listing.

Large scale, grid interactive lead-acid ESS such as in the Hawaii fire that did not originate in the batteries would still require an Emergency Operations and Emergency Response Plan.

Related Item

- FR-15

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Wed May 08 10:59:50 EDT 2024
Committee: ESS-AAA

Public Comment No. 170-NFPA 855-2024 [Section No. 4.3.2 [Excluding any Sub-Sections]]

~~For ESS installations, an emergency~~ ESS emergency operations plan and associated training shall be established, maintained, and conducted by ESS facility operations and maintenance personnel.

Statement of Problem and Substantiation for Public Comment

Remove the word "For" at the start of this requirement as it is not needed after FR-16 deleted the language that was previously in this requirement. Delete the word "installations" as this is redundant.

Related Item

- FR-16

Submitter Information Verification

Submitter Full Name: Darryl Hill
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Submittal Date: Sun May 26 14:05:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 8-NFPA 855-2024 [Section No. 4.3.2 [Excluding any Sub-Sections]]

For ESS installations ~~, an~~ exceeding the values shown in Table 4.3.1, an emergency operations plan and associated training shall be established, maintained, and conducted by ESS facility operations and maintenance personnel.

Statement of Problem and Substantiation for Public Comment

As noted in PC-7, the threshold ESS energy levels dictating the need for Emergency Planning and Training were increased in the 2023 edition. The Committee statement justifying this change was:

The requirement to have emergency training and an operations plan seems excessive for the deployment [of] commercial products that are deployed in accordance with this standard and used consistent with their listing. For larger commercial or utility scale sites with dedicated maintenance staff the requirement is proper, but it seems excessive for smaller sites that are not dedicated ESS installations. An example of the latter could be a UPS system in a commercial facility that is just over the thresholds of Table 1.3. For systems such as these, understanding and following the operations and maintenance manual, as provided by the manufacturer, should be sufficient. Installations exceeding Table 4.8 [MSE values] are considered higher hazards and would warrant the training and operations plan as described.

I agree with the position that Emergency Planning and Training for installations below the Maximum Stored Energy Limits are warranted, but I feel a threshold between the table 1.3 values and the Maximum Stored Energy Limits makes the most sense and is consistent with the Technical Committees action in the 2023 edition. A set of limits below the MSE at roughly 5x the table 1.3 values are suggested as a starting point

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 7-NFPA 855-2024 [Section No. 4.3.1]	Same issue

Related Item

- FR-15

Submitter Information Verification

Submitter Full Name: Richard Kluge

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Submittal Date: Tue Mar 12 13:45:59 EDT 2024

Committee: ESS-AAA

Public Comment No. 116-NFPA 855-2024 [Section No. 4.3.2.1]

4.3.2.1– **Emergency** ~~**Operations**~~ **Action Plan** ~~.~~

4.3.2.1.1

–

An emergency

~~operations plan shall~~

action plan following 29 CFR 1910.38 shall be readily available for use by facility operations and maintenance personnel.

~~**4.3.2.1.2**~~ –

~~The emergency operations plan shall be on site in an approved location or available digitally where approved.~~

~~**4.3.2.1.3**~~ –

~~The plan shall be updated when conditions that affect the response considerations and procedures change.~~

~~**4.3.2.1.4**~~ –

~~The emergency operations plan shall include the following:~~

(1) ~~Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries~~

(2) ~~Procedures for inspection and testing of associated alarms, interlocks, and controls~~

(3)~~*~~ ~~Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required~~

(4)~~*~~ ~~Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions~~

(5) ~~Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required~~

(6) ~~Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility~~

(7) ~~Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders~~

(8) ~~Procedures and schedules for conducting drills of these procedures~~

Statement of Problem and Substantiation for Public Comment

With the addition of an Emergency Response Plan requirement in proposed Section 4.3.3, this section is redundant as all items are covered by documents required elsewhere in the standard or by federal law (the EAP). Companies already train workers to the EAP and will additionally train them to the ERP with the new inclusion in Section 4.3.3

Here is how each is already being covered:

(1) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries, and for safe start-up following cessation of emergency conditions

Covered by: UL Listed BMS (automated shutdowns), Operations and Maintenance Manuals, Decommissioning Plan

(2) Procedures for inspection and testing of associated alarms, interlocks, and controls

Covered by: Maintenance Manuals, NFPA standards referenced within this standard

(3) Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required

Covered by: UL listed BMS (automated shutdowns), Operations and Maintenance Manuals, Emergency Response Plan

(4) Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions

Covered by: Emergency Response Plan, (OHSA required) Emergency Action Plans

(5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required

Covered by: Emergency Response Plan, (OHSA required) Emergency Action Plans

(6) Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility

Covered by: Decommissioning Plan

(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders

Covered by: Emergency Response Plan

(8) Procedures and schedules for conducting drills of these procedures

Covered by: N/A if removed

Related Item

- FR 17

Submitter Information Verification

Submitter Full Name: Daniel Clark
Organization: Terra-Gen
Street Address:
City:
State:
Zip:
Submittal Date: Tue May 21 16:54:56 EDT 2024

Committee: ESS-AAA

Public Comment No. 276-NFPA 855-2024 [New Section after 4.3.2.1.4]

Add 4.3.2.1.5:

Lead acid and nickel cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.3.2.1.

Additional Proposed Changes

File Name	Description	Approved
NATF_Public_Comment_No._276-NFPA_855-2024.pdf	NATF Letter	

Statement of Problem and Substantiation for Public Comment

Please see letter submitted via email on May 30, 2024 to custserv@nfpa.org. Filename: NATF Public Comment No. 276-NFPA 855-2024. This letter explains the issue that would be resolved by the proposed change and our rationale for the change.

Related Item

- FR-88 Public Input No 227-NFPA 855-2023 [Section No,. 4.3.2.1.5]

Submitter Information Verification

Submitter Full Name: Lee Underwood
Organization: North American Transmission Forum
Street Address:
City:
State:
Zip:
Submittal Date: Thu May 30 08:02:58 EDT 2024
Committee: ESS-AAA

NATF
North American Transmission Forum

Thomas J. Galloway Sr.
NATF President and CEO
9115 Harris Corners Parkway
Charlotte, NC 28269

May 30, 2024

National Fire Protection Association (NFPA)
Attn: Standards Administration
1 Batterymarch Park
Quincy, Massachusetts 02169

Re: Public Comment No. 276-NFPA 855-2024

The North American Transmission Forum (NATF) appreciates the opportunity to provide comments to the NFPA's 855 Standard for the Installation of Stationary Energy Storage Systems. The NATF members represent about 90% of the peak load and 85% of the high-voltage transmission circuit miles in the U.S. and Canada. NATF's mission is to promote excellence in the safe, reliable, secure, and resilient operation of the electric transmission system. The primary mechanism used to advance our mission is to leverage member subject matter expertise to solve complex challenges. The subject of this letter is one such challenge – working to advance safety while avoiding unintended reliability impacts. While the comments provided herein may not necessarily reflect the opinion of every individual NATF member, they reflect a broad consensus.

The NATF understands the motivation behind proposed changes to NFPA 855 – safety is a primary concern in the operation of the bulk-power system. However, the proposed changes eliminate the existing exemption for an emergency operations plan (EOP) for utility-owned batteries currently provided by NFPA 855 section 4.3.2.1.5. We are concerned about reliability due to the unintended impact this change could have on the operation and management of relatively small lead-acid and nickel-cadmium batteries, which are used for control functions, short-circuit protection, and other protection functions within utility facilities.

We encourage the NFPA to, with input from the technical experts, develop an exemption that accomplishes both safety for our fire-fighters and reliability for the public. Rather than eliminating 4.3.2.1.5, it could be revised as follows:

Lead acid and nickel cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.3.2.1.

To support this suggestion, we offer additional comments for consideration:

1. Electrical substations contain uninsulated high-voltage, high-energy sources; full situational awareness is needed for everyone who enters. Regardless of an EOP, utility personnel that are familiar with the substation are needed to provide direction to emergency responders prior to their entering the facility, just as they would for any other electrical emergency.

2. Utility personnel are familiar with their utility's unique procedures to safely respond to a variety of emergencies that can happen in these facilities, and it is unrealistic to expect fire-fighters to be trained on all such procedures.
3. Control batteries provide power to monitor conditions in the facility, to perform switching operations necessary to maintain the reliability of the electrical system, and operate circuit breakers to protect the public, first responders, utility equipment, and electrical system reliability under abnormal conditions. Isolating the control battery defeats all the electrical safety features in the substation, thus creating safety hazards and the potential for a cascading event on the electrical system.
4. While the total capacity of the control batteries in some substations is less than 70kWh, the aggregate capacity in the largest and most critical substations is typically above 70kWh and would be subject to NFPA 855.
5. Notwithstanding the fact that many substation control batteries will be subject to NFPA 855, these control batteries, even in the aggregate, are much smaller than a typical grid-connected battery energy storage system.
6. Control batteries are typically of lead-acid or nickel-cadmium chemistry. Utilities have extensive experience with the safe operation of these batteries.
7. Most utilities operate facilities across a wide area. Many have operations in more than one state and in multiple jurisdictions.
8. Eliminating the existing exemption for emergency operations plan (EOP) provided by NFPA 855 section 4.3.2.1.5 could subject utilities to many different interpretations of what should be included in an EOP. Section 4.3.2.1.4 (7) gives various local authorities having jurisdiction the ability to require the utility to implement a different process (and perhaps different designs) in each of the jurisdictions in which the utility operates. Such locally determined requirements may run counter to national standards and practices established to ensure the physical security of substations and reliable operation of the electrical grid. Rather than enhancing safety, such locally mandated variation could be detrimental to the safety of utility employees who must respond to abnormal events.

We understand that members of the technical committee have commented on the potential unintended consequences of the proposed changes and have suggested alternatives that address the concerns while limiting these unintended consequences. Again, we appreciate the opportunity to comment and strongly encourage the technical committee to consider these comments.

Sincerely,

Thomas J. Galloway, Sr.

NATF President and CEO

Public Comment No. 296-NFPA 855-2024 [New Section after 4.3.2.1.4]

4.3.2.1.5

Lead acid and nickel cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.3.2.1 [4.3.2.1]

Statement of Problem and Substantiation for Public Comment

A broader utility exemption for all battery technology was removed during the first draft. This proposal restores the exemption for lead acid and nickel cadmium batteries used for control / safe shutdown of substation and power generating facilities. These batteries provide power for systems such as protective relays whose disabling would create a larger hazard than that posed by the battery itself. The process to disable these batteries (without utility support) will also expose first responders to significant risk

Related Item

- PI 227

Submitter Information Verification

Submitter Full Name: Justin Perry
Organization: Dominion Energy
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City:
State:
Zip:
Submittal Date: Thu May 30 13:00:41 EDT 2024
Committee: ESS-AAA

Public Comment No. 340-NFPA 855-2024 [New Section after 4.3.2.1.4]

TITLE OF NEW CONTENT

4.3.2.1.5

Lead acid and nickel cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.3.2.1

Statement of Problem and Substantiation for Public Comment

The original carveout in Section 4.3.2.1.5 exempting dc control systems utilizing lead acid – nickel cadmium batteries should be restored. NFPA 850 should serve as the governing document to manage fire risk associated with lead acid and nickel cadmium batteries in generating stations and substations. These systems have been in place for over 50 years without incident which is why a carveout was granted by NFPA 855 to the utilities. In addition, Section 5.4 of NFPA 850 requires a Fire Emergency Plan similar to NFPA 855 – 4.3.2.1.1.

Related Item

- 4.3.2.1.5

Submitter Information Verification

Submitter Full Name: Anthony Natale
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Submittal Date: Thu May 30 16:30:21 EDT 2024
Committee: ESS-AAA

Public Comment No. 345-NFPA 855-2024 [New Section after 4.3.2.1.4]

4.3.2.1.5

The emergency operations plan in 4.3.2.1 shall not be required for electric utility facilities under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations.

Statement of Problem and Substantiation for Public Comment

As previous draft comments have indicated and our own internal Mx folks have confirmed, such procedures and plans are already in place but removal of this clause will add additional burden of documentation and administration to show requirements are met. ATC would support appending this exemption to just Li-Ion or even raising the 70kWh limit for lead acid batteries as that limit is quite easy to hit for critical substations requiring redundant battery systems (often in a single fire area or control house).

ATC also agrees with the potential security concerns created with the ability to submit a freedom of information act request disclosing sensitive information to critical substation infrastructure.

Related Item

- FR-88

Submitter Information Verification

Submitter Full Name: Jim Zhong
Organization: American Transmission Company
Street Address:
City:
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Zip:
Submittal Date: Thu May 30 16:51:29 EDT 2024
Committee: ESS-AAA

Public Comment No. 125-NFPA 855-2024 [Section No. 4.3.2.1.4]

4.3.2.1.4

The emergency operations plan shall include the following:

(1) General information including site details, product details, contact information

(2) Hazards

(3) Command structure and roles

(4) Procedures for safe shutdown, de-energizing, or isolation of equipment and systems under emergency conditions to reduce the risk of fire, electric shock, and personal injuries

(5) ~~Procedures for inspection and testing of associated alarms, interlocks, and controls~~

(6)* Procedures to be followed in response to notifications of system alarms or out-of-range conditions that could signify potentially dangerous conditions, including shutting down equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required

(7)* Emergency procedures to be followed in case of fire, explosion, release of liquids or vapors, damage to critical moving parts, or other potentially dangerous conditions

(8) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required

~~Procedures for dealing with ESS equipment damaged in a fire or other emergency event, including contact information for personnel qualified to safely remove damaged ESS equipment from the facility~~

(9) Post incident operations to monitor for reignition or other hazards

(10) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders

(11) Procedures and schedules for conducting drills of these procedures

Statement of Problem and Substantiation for Public Comment

procedures for inspection and testing are not appropriate for emergency response plan and should be in operations and maintenance manual
Procedure for dealing with damaged units should be the decommissioning plan
missing post incident considerations(lock out tag out, thermal assesment criteria, gas monitoring, etc.)

Related Item

- First Revision No. 87-NFPA 855-2023 [Section No. 4.3.2.1.4]

Submitter Information Verification

Submitter Full Name: Chris Groves
Organization: Wartsila North America
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City:
State:
Zip:
Submittal Date: Wed May 22 16:38:57 EDT 2024

Committee: ESS-AAA

Public Comment No. 115-NFPA 855-2024 [Section No. 4.3.2.2.2]

4.3.2.2.2

Personnel responsible for the operation, maintenance, and repair of the ESS shall be trained in the procedures included in the emergency operations plan in 4.3.2.1 prior to the ~~commissioning~~ operation of the ESS.

Statement of Problem and Substantiation for Public Comment

The time gap between integrated ESS cabinets arriving on site and the start of commissioning for our recent projects effectively makes 4.3.2.2.1 and 4.3.2.2.2 the same time (approx. 1-3 week gap). Additionally, the liability for the project site remains with the installer/contractor though commissioning. Liability is turned over to the owner/operator at "substantial completion" at which point the ESS goes into operation. This edit provides a more reasonable time gap and legal liability alignment between ESS delivery and operations in which the operators and maintenance technicians can be trained prior to them taking over the facility.

Related Item

- FR 89

Submitter Information Verification

Submitter Full Name:	Daniel Clark
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City:	
State:	
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Submittal Date:	Tue May 21 15:00:30 EDT 2024
Committee:	ESS-AAA

Public Comment No. 9-NFPA 855-2024 [Section No. 4.3.3]

4.3.3 Emergency Response Plan.

4.3.3.1 General.

For ESS installations ~~, an~~ exceeding the values shown in table 4.3.3. 1, an emergency response plan and associated training shall be established, maintained, and conducted so that ESS facility operations personnel and emergency responders can address foreseeable hazards associated with the on-site emergencies.

Table 4.3.3. 1 Quantities per Each Fire Area or Outdoor Installation for Determination of Emergency Planning and Training

	Aggregate Capacity	
ESS Technology	kWh	MJ
Battery ESS		
Lead-acid, all types	2400	8640
Ni-Cd, Ni-MH, and NiZn	2400	8640
Lithium-ion, all types	600	2160
Sodium-nickel chloride	600	2160
Flow batteries	600	2160
Other battery technologies	200	720
Capacitor ESS	20	72
Flywheel ESS	50	180
All other ESS	200	720

4.3.3. 2 Emergency Response Plan.

4.3.3.2.1

The emergency response plan shall be in accordance with Chapters 17 through 23 of NFPA 1660.

4.3.3.2.2

The emergency response plan shall, at a minimum, address the following:

(1) Mitigation
(2) Preparedness
(3) Response
(4) Recovery

4.3.3.3 Training.

4.3.3.3.1

Personnel responsible for the installation of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the ESS arriving onsite.

4.3.3.3.2

Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the commissioning of the ESS.

4.3.3.4 Refresher Training.

4.3.3.4.1

Refresher training shall be conducted by ESS facility operations personnel at least annually.

4.3.3.4.2

Records of such training shall be retained in an approved manner.

4.3.3.5 Notification.

Emergency responders shall be notified of the training dates and locations.

Statement of Problem and Substantiation for Public Comment

As with Section 4.2.1.2 and its associated PC-7, a threshold value for this new section is needed or it will be needlessly applied to small commercial UPSs that are in the scope of the standard. Another option is to limit this to the technologies that most warrant this planning, such as lithium-ion.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 7-NFPA 855-2024 [Section No. 4.3.1]	Same concern.

Related Item

- PC-7

Submitter Information Verification

Submitter Full Name:	Richard Kluge
Organization:	NEBScore Inc.
Affiliation:	ATIS
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Mar 12 14:06:36 EDT 2024
Committee:	ESS-AAA

Public Comment No. 171-NFPA 855-2024 [Section No. 4.3.3.1]

4.3.3.1 General.

~~For ESS installations, an emergency~~ ESS emergency response plan and associated training shall be established, maintained, and conducted so that ESS facility operations personnel and emergency responders can address foreseeable hazards associated with the on-site emergencies.

Statement of Problem and Substantiation for Public Comment

Remove the word "For" at the start of this requirement as it is not needed for this requirement. Delete the word "installations" as this is redundant.

Related Item

- FR-17

Submitter Information Verification

Submitter Full Name:	Darryl Hill
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City:	
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Zip:	
Submittal Date:	Sun May 26 14:11:55 EDT 2024
Committee:	ESS-AAA

Public Comment No. 117-NFPA 855-2024 [Section No. 4.3.3.2.1]

4.3.3.2.1

The emergency response plan shall be in accordance with Chapters 1 through 3, and Chapters 17 through 23 of NFPA 1660.

Statement of Problem and Substantiation for Public Comment

The inclusion of Chapters 1 through 3 are relevant to the standards referenced and definitions used in Chapters 17 through 23. Effectively, NFPA 1620.

Related Item

- FR 17

Submitter Information Verification

Submitter Full Name: Daniel Clark
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Street Address:
City:
State:
Zip:
Submittal Date: Tue May 21 17:40:09 EDT 2024
Committee: ESS-AAA

Public Comment No. 118-NFPA 855-2024 [New Section after 4.3.3.2.2]

4.3.3.2.3

The emergency response plan shall be developed during the design phase in coordination with the AHJ. The AHJ is to provide the format of the emergency response plan.

Statement of Problem and Substantiation for Public Comment

Many ERPs are developed by without input from the AHJ and are not submitted until too late (if at all). Additionally, the format of the ERPs differ depending on the company that developed it. That can lead to them being disregarded by the first responders as unhelpful. This change would ensure coordination with the AHJ to make sure the content is appropriate, require early submission of the plan to have it in place before the ESS goes in operation, and ensure that the ERP format aligns with the AHJ specific needs so the information is easy to digest by the first responders.

Related Item

- FR 17

Submitter Information Verification

Submitter Full Name:	Daniel Clark
Organization:	Terra-Gen
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue May 21 17:53:32 EDT 2024
Committee:	ESS-AAA

Public Comment No. 119-NFPA 855-2024 [Section No. 4.3.3.3.2]

4.3.3.3.2

Personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS shall be trained in the procedures included in the emergency response plan in 4.3.3 prior to the ~~commissioning~~ operation of the ESS.

Statement of Problem and Substantiation for Public Comment

The time gap between integrated ESS cabinets arriving on site and the start of commissioning for our recent projects effectively makes 4.3.3.3.1 and 4.3.3.3.2 the same time (approx. 1-3 week gap). Additionally, the liability for the project site remains with the installer/contractor though commissioning. Liability is turned over to the owner/operator at "substantial completion" at which point the ESS goes into operation. This edit provides a more reasonable time gap and legal liability alignment between ESS delivery and operations in which the operators and maintenance technicians can be trained prior to them taking over the facility.

Related Item

- FR 17

Submitter Information Verification

Submitter Full Name: Daniel Clark
Organization: Terra-Gen
Street Address:
City:
State:
Zip:
Submittal Date: Tue May 21 18:36:52 EDT 2024
Committee: ESS-AAA

Public Comment No. 341-NFPA 855-2024 [Section No. 4.3.3.4.1]

4.3.3.4.1

Refresher training shall be conducted by ESS facility operations personnel at least annually. Refresher training may be combined to cover all sites rather than each site individually. {It is our concern that with potentially having multiple sites in our ownership that would qualify that individual training for each site will become too resource intensive. We want to be sure that it is OK to have a single refresher training session each year to cover ALL sites that qualify for the purposes of efficiency.}

Statement of Problem and Substantiation for Public Comment

Provide clarification that allows a single refresher meeting instance to cover all impacted ESS facilities in a given footprint.

Related Item

- FR-24

Submitter Information Verification

Submitter Full Name:	Jim Zhong
Organization:	American Transmission Company
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu May 30 16:44:20 EDT 2024
Committee:	ESS-AAA

Public Comment No. 85-NFPA 855-2024 [Section No. 4.4]

4.~~4~~ 2 Hazard Mitigation Analysis (HMA).

4.~~4~~ 2 .1*

A hazard mitigation analysis shall be provided to the AHJ for review and approval~~ where any of the following conditions are present:~~

(1) ~~Technologies not specifically addressed in Table 1.3 are provided~~

(2) ~~More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible~~

(3) ~~Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2~~

(4) ~~Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements~~

(5) ~~Where required for existing lithium-ion ESSs that are not UL 9540 listed in accordance with 9.2.2.1~~

(6) ~~Where required for outdoor lithium-ion battery ESSs in accordance with 9.5.2.1~~

(7) ~~Where required by the AHJ for existing systems (retroactivity) in accordance with 1.4.2~~

~~4.4.2~~

~~.~~

4.2.2 Failure Modes.

4.~~4~~ 2 .2.1*

The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:

(1) A thermal runaway or mechanical failure condition in a single ESS unit

(2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)

(3) Failure of a required system including, but not limited to, exhaust ventilation~~ (HVAC)~~ , cooling system, BMS, communication system, or other critical systems that might impact normal operations

4.~~4~~ 2 .2.2

Only single failure modes shall be considered for each mode given in 4.4.2.1.

4.~~4~~ 2 .2.3*

Consequences of single failures of a critical safety component or system, such as exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection or explosion ~~control systems~~ prevention system , during a thermal runaway or failure event shall be evaluated.

4.~~4~~ 2 .3

The AHJ shall be permitted to approve the hazard mitigation analysis as documentation of the safety of the ESS installation if the consequences of the analysis demonstrate the following:

(1) Fires will be contained within unoccupied ESS rooms for the minimum duration of the fire resistance rating specified in 9.6.5.

(2) Fires and products of combustion will not prevent occupants from evacuating to a safe location.

(3) Deflagration hazards will be addressed by an explosion control or other system.

4.~~4~~ 2 .4

The hazard mitigation analysis shall be documented and made available to the AHJ and those authorized to design and operate the system.

4.~~4~~ 2 .5*

Construction, equipment, and systems that are required for the ESS to comply with the hazard mitigation analysis shall be installed, tested, and maintained in accordance with this standard and the manufacturer's instructions.

Statement of Problem and Substantiation for Public Comment

Suggest to make the HMA mandatory and make it first step in AHJ approval process. A full assessment of the safety via the HMA should come before the other construction documentation currently in 4.2. Review of the critical safety components as part of the HMA can subsequently be used to determine which systems require emergency power.

Related Item

- FR-138

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: ATIS
Street Address:
City:
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Submittal Date: Tue Apr 23 16:32:24 EDT 2024
Committee: ESS-AAA

Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]

4.4.1*

A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:

(1) Technologies not specifically addressed in Table 1.3 are provided

(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible

(3) Where ~~allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2~~ - an ESS technology is used that does not pass the cell level criteria of UL 9540A.

(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements

(5) Where required for existing lithium-ion ESSs that are not UL 9540 listed in accordance with 9.2.2.1

(6) Where required for outdoor lithium-ion battery ESSs in accordance with 9.5.2.1

(7) Where required by the AHJ for existing systems (retroactivity) in accordance with 1.4.2

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	
Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]	
Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name:	Robert Davidson
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Street Address:	
City:	
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Zip:	
Submittal Date:	Thu May 30 13:33:58 EDT 2024
Committee:	ESS-AAA

Public Comment No. 338-NFPA 855-2024 [Section No. 4.4.2.1]

4.4.2.1*

The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:

(1) A thermal runaway or mechanical failure condition in a single ESS unit

(2) Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)

(3) Failure of a required system including, but not limited to, ventilation (HVAC), cooling system, BMS, communication system, or other critical systems that might impact normal operations

(4) Evaluation of site-specific exposure impacts based on a the results of the large scale fire testing

Statement of Problem and Substantiation for Public Comment

From TG 9, need HMA to account for the impacts and exposures to target units and other exposures

Related Item

- PI 1

Submitter Information Verification

Submitter Full Name: Noah Ryder
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City:
State:
Zip:
Submittal Date: Thu May 30 16:23:16 EDT 2024
Committee: ESS-AAA

Public Comment No. 10-NFPA 855-2024 [Section No. 4.4.2.3]

4.4.2.3*

Consequences of a single ~~failures~~ failure of a critical safety component or system, such ~~as exhaust ventilation, smoke~~ as smoke detection, fire detection, fire suppression, or gas detection or explosion ~~control systems~~ prevention system , during a thermal ~~runaway or failure event~~ runaway event shall be evaluated.

Statement of Problem and Substantiation for Public Comment

Change explosion control to explosion prevention to be consistent with other revised text in section 9. Remove exhaust ventilation as it is covered by explosion prevention if that is the intent of the ventilation. If abnormal events in addition to thermal runaway are to be analyzed, they should be listed, otherwise the requirement is very open ended. I don't think this is warranted for lead-acid and NiCd that require extremely low ventilation rates to disperse hydrogen under normal operating conditions, and maybe some exclusion is needed or else every UPS will require NFPA 110/111 emergency power on the serving ventilation fan when this is not justified by the loss record of these systems.

Related Item

- FR-138

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: ATIS
Street Address:
City:
State:
Zip:
Submittal Date: Tue Mar 12 20:21:02 EDT 2024
Committee: ESS-AAA

Public Comment No. 150-NFPA 855-2024 [Section No. 4.4.2.3]

4.4.2.3*

Consequences of single failures of a critical safety component or system, such as exhaust ventilation, smoke detection, fire detection, fire suppression, ~~or gas~~ CGCRS, gas detection or explosion control systems, during ~~a~~ thermal runaway propogation or failure event shall be evaluated.

Statement of Problem and Substantiation for Public Comment

With modification to the explosion chapter and the addition of a combustible gas concentration reduction system, CGCRS, the term needs to be added to the FMEA requirements of a critical safety system.

Related Item

- FR 138

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 110-NFPA 855-2024 [Section No. 4.4.4]

4.4.4

The hazard mitigation analysis shall be documented and made available to the AHJ and those authorized to design and operate the system. It is strongly recommended to conduct the hazard mitigation analysis with Battery Analytics Software to determine the impact and associated risk of the single points of failure within the ESS.

Statement of Problem and Substantiation for Public Comment

It will be in the AHJ's interest to receive the deep, electrochemical analysis of the ESS in order to detect and prevent the fire hazards presented by the single points of failure that currently exist within the system (BMS, HVAC, rack/module/cell abnormal behavior, etc.).

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 107-NFPA 855-2024 [New Section after 9.2.1.1]	PI 248
Public Comment No. 108-NFPA 855-2024 [New Section after 9.2.2]	PI 248
Public Comment No. 111-NFPA 855-2024 [New Section after 3.3]	
Public Comment No. 112-NFPA 855-2024 [Section No. 9.2.1.1]	

Related Item

- PI 248

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Public Comment No. 147-NFPA 855-2024 [New Section after 4.6.1]

4.6.1.1

ESS not containing an integrated inverter shall be listed to UL 9540 as an energy storage equipment subassembly.

Statement of Problem and Substantiation for Public Comment

Most large scale ESS projects do not include the inverter as part of the ESS "DC block" and this has led to a lack of listed products for large scale ESS. UL offers a UL 9540 certification for the "DC block" of an ESS called the "energy storage equipment subassembly" (ESES) which would best align with how large ESS projects are built.

Related Item

- PI 164
- PI 244
- PI 335

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Committee: ESS-AAA

Public Comment No. 245-NFPA 855-2024 [New Section after 4.6.1]

4.6.2 *

The AHJ is authorized to approve an ESS that is not listed in accordance with 4.6.1 using a Energy Storage System certification that complies with 4.6.2.

A.4.6.2 . Energy storage systems (ESS), with a few exceptions for certain lead-acid ESS, are required to be listed in accordance with UL 9540. This is a very complex standard with detailed construction, performance (testing) and functional safety requirements that cover the ESS, including cells, modules, controls, battery management system, and the overall system interaction.

Because of the complexity of the UL 9540 requirements, this proposal puts guard rails in place for situations where ESS is present at an installation site that has not been listed to UL 9540, and a field evaluation is being considered by the AHJ to supplement the 1973 listings for approving the ESS.

Due to the complex nature of UL 9540 construction, performance and functional safety requirements, and the UL 9540A fire propagation testing requirements that are incorporated in UL 9540, certification of ESS need to be performed by a competent, qualified organizations and individuals. This section identifies the qualifications of agencies that can perform UL 9540 field evaluations component. This includes accredited certification organizations and accredited certification bodies.

> The NFPA 790 Standard for Competency of Third-Party certification Bodies includes general requirements for the qualification and competency of a body performing field evaluations on electrical products and assemblies with electrical components. However there are no specific qualifications identified for FEB that conduct field evaluations of ESS, and these can be categorized under the Appendix C electrical products groups as “Other similar electrical products”. A careful review of the FEB qualifications for conducting ESS field evaluations should be considered.
>
> The NFPA 791 Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation provides recommended procedures for evaluating unlabeled electrical equipment in conjunction with nationally recognized standard(s) applicable to the subject equipment and any requirements of the authority having jurisdiction (AHJ).

The requirements in this section are intended to form the technical basis for how the requirements in 1.5 are to be applied to determine equivalency to a UL 9540 listing.

4.6.2.1 Documentation. The owner or their authorized agent shall provide at no charge to the AHJ documentation showing compliance with all 4.6.2 requirements.

4.6.2.2* UL9540 Certification Evaluation. The certification shall evaluate the ESS for compliance for all UL 9540 construction, technical, performance, quality, and functional safety requirements. Any deviation from UL9540 shall be identified in the certification report and approved by the AHJ

A.4.6.2.2 The report shall be provided to identify any exceptions to the 9540 listings. If the certified body takes any exceptions to the 9540 listings. They shall clearly identify. The HMA shall address any exceptions and provide alternate methods and means to insure core safety requirements are met.

> 4.6.2.3* Functional Safety. The. Functional Safety review and analysis of ESS in support of the certification shall include documentation demonstrating the FEB’s compliance with the qualification criteria in UL 9540.

A.4.6.2.3 The standards referred in UL 1973 and UL 9540 for functional safety are:

a) UL 991 and UL 1998;

c) Annex H of UL 60730-1 (Function Class B requirements);

d) IEC 61508 (all parts) (minimum of Safety Integrity Level (SIL) "2" requirements for active protective devices with software controls);

e) ISO 13849-1 and ISO 13849-2 (minimum of Performance Level (PL) "c" requirements for active protective devices with software controls); or

f) ISO 26262 (all parts) (minimum Automotive Safety Integrity Level (ASIL) "C" requirements for active protective devices with software controls).

4.6.2.4 * Battery listings.

All battery cells, modules or rack-mounted-modules in the ESS shall be listed and labeled in accordance with UL 1973.

A.4.6.2.4 Several AHJs have expressed interest in having the battery cells, modules or rack-mounted modules covered by a factory audit inspection program. Requiring these components to be listed and labeled in accordance with UL 1973 includes this factory surveillance. In addition the UL 1973 covers not only the cells, but also covers the battery management system and other safeguards.

Numerous BESS fires have been attributed to poorly manufactured Li-Ion battery cells (contaminants, damaged membranes, inadequate spacings). To minimize these problems, this section mandates that at least the cells be certified in accordance with UL1973. Battery modules and rack-mounted modules that contain UL 1973 listed cells can be assessed as part of a field evaluation component as long as it can be shown that all applicable testing to UL1973 is conducted and the testing is representative of the battery modules and racks installed.

4.6.2.5 * Applicability.

The certification report shall clearly identify the construction and components of the ESS covered by the field evaluation component, as verified at the installation site.

A.4.6.2.5 When evaluating if a certification is applicable to a given installation, the designer and AHJ should verify that the construction of the ESS at the installation site is the same as the ESS documented in the certification report. This addresses the situation where, for example, a field evaluation component report is based on the use of a particular manufacturer and model of battery cells, but the ESS at the installation site includes different battery cells.

Statement of Problem and Substantiation for Public Comment

With alternate methods of construction and fabrication such as Buildings, final assembly on site, supply chain aggregation, and other technologies that may not lend themselves to completion in the factory such as flow batteries, a 9540 listing at the factory may not be feasibly or even possible. This provides a option for meeting the compliance criteria of 9540 with out lessening the standard.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 244-NFPA 855-2024 [Section No. 3.3.12]	
Public Comment No. 242-NFPA 855-2024 [Section No. 3.3.14]	
Public Comment No. 246-NFPA 855-2024 [Section No. 4.6.1]	

Related Item

- CI 182

Submitter Information Verification

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Submittal Date:	Wed May 29 11:06:16 EDT 2024
Committee:	ESS-AAA

Public Comment No. 260-NFPA 855-2024 [New Section after 4.6.1]

4.6.2.5 * Battery listings.

All battery cells, modules or rack-mounted-modules in the ESS shall be listed and labeled in accordance with UL 1973.

Cells that have been tested to UL 9540A and demonstrated that thermal runaway is not possible shall not require a UL 1973 listing.

Statement of Problem and Substantiation for Public Comment

Form Energy supports the addition of field evaluation criteria to NFPA 855 and agrees with the UL 1973 listing prerequisite for chemistries that undergo thermal runaway such as lithium ion. The factory surveillance required for a UL 1973 listing is critical for chemistries that can result in a violent thermal runaway event from a manufacturing defect within the cell.

An exception to this new requirement is recommended, as chemistries that have demonstrated an inability to go into thermal runaway pose a significantly lower risk to system safety and can be sufficiently evaluated with current field evaluation procedures.

Related Item

- CI-182

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Committee: ESS-AAA

Public Comment No. 246-NFPA 855-2024 [Section No. 4.6.1]

4.6.1* Listings.

~~ESSs~~ ESSs shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard .

4.6.1.1* ESS shall be permitted to be comprised of listed DC ESS, PCS and ESMS components installed in the field according to section 4.6.2.

4.6.1.2 Battery Systems, DC ESS, PCS, ESMS and other major components with Critical Safety Systems shall be listed to the appropriate standards and all Critical Safety Systems, as identified in 4.4.2.3, shall be evaluated as part of the listing, with excluded items clearly included in the labeling of the component.

4.6.1.3 All Critical Safety Systems in 4.4.2.3 shall be included in at least one component listing and the equipment shall be listed and labeled for the Critical Safety System.

4.6.1.4 Software based Critical Safety Systems, as identified in 4.4.2.3, shall be listed for functional safety and software integrity via UL 991 and UL 1998.

A.4.6.1.1 Energy Storage System Types

Integrated Energy Storage Systems

Fully integrated ESS, with battery system, integrated battery system controller, AC/DC protection, thermal management and PCS.

A screenshot of a computer Description automatically generated

Component ESS – DC ESS, PCS and ESMS

Productized units from major suppliers. In most cases the integrator provides the integrated battery system and ESMS, with PCS supplied by an entity other than the integrator. The integrator will most likely wrap the supplied system. Owner may procure major components (IBS and PCS) directly.

A screenshot of a computer screen Description automatically generated

Component ESS – Building Enclosed

Owner is procuring and integrating all major equipment. The enclosure is a purpose-built enclosure with all batteries residing in a single structure. Owner direct procurement of the battery system.

A computer screen shot of a diagram Description automatically generated

Stacked DC ESS or Battery Systems

Stacking of productized solutions in the field. The certification path remains the same. The systems must be tested per UL 9540A at the installation level with units adjacent to the primary unit, per the site layout or more intense.

s shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard.

Additional Proposed Changes

File Name	Description	Approved
TG_22_Modifications_4.6.1.docx	Annex material to PC for charts.	

Statement of Problem and Substantiation for Public Comment

With alternate methods of construction and fabrication such as Buildings, final assembly on site, supply chain aggregation, and other technologies that may not lend themselves to completion in the factory such as flow batteries, a 9540 listing at the factory may not be feasibly or even possible. This provides a option for meeting the compliance criteria of 9540 with out lessening the standard.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 245-NFPA 855-2024 [New Section after 4.6.1]	
Public Comment No. 242-NFPA 855-2024 [Section No. 3.3.14]	
Public Comment No. 247-NFPA 855-2024 [Section No. 2.3.9]	

Related Item

- CI 182

Submitter Information Verification

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Submittal Date: Wed May 29 11:44:03 EDT 2024
Committee: ESS-AAA

4.6.1* Listings.

ESSs shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard.

A.4.6.1

It is envisioned that equipment provided will be listed in accordance with UL 9540. ESSs that are not listed in accordance with UL 9540 should be documented and verified as meeting the provisions of this standard using the equivalency requirements in Section 1.5, where technical documentation provided shows the ESS that is proposed results in a system that is no less safe than a system meeting the construction and performance requirements of UL 9540. If nonlisted equipment is to be evaluated for compliance with UL 9540, the evaluation and documentation should be provided as part of a field evaluation conducted by an approved third-party certification organization.

In specific instances, this standard will not require equipment such as lead-acid batteries to be listed or they can be listed to UL 1973 instead of UL 9540.

4.6.1.1* ESS shall be permitted to be comprised of listed DC ESS, PCS and ESMS components installed in the field according to section 4.6.2.

4.6.1.2 Battery Systems, DC ESS, PCS, ESMS and other major components with Critical Safety Systems shall be listed to the appropriate standards and all Critical Safety Systems, as identified in 4.4.2.3, shall be evaluated as part of the listing, with excluded items clearly included in the labeling of the component.

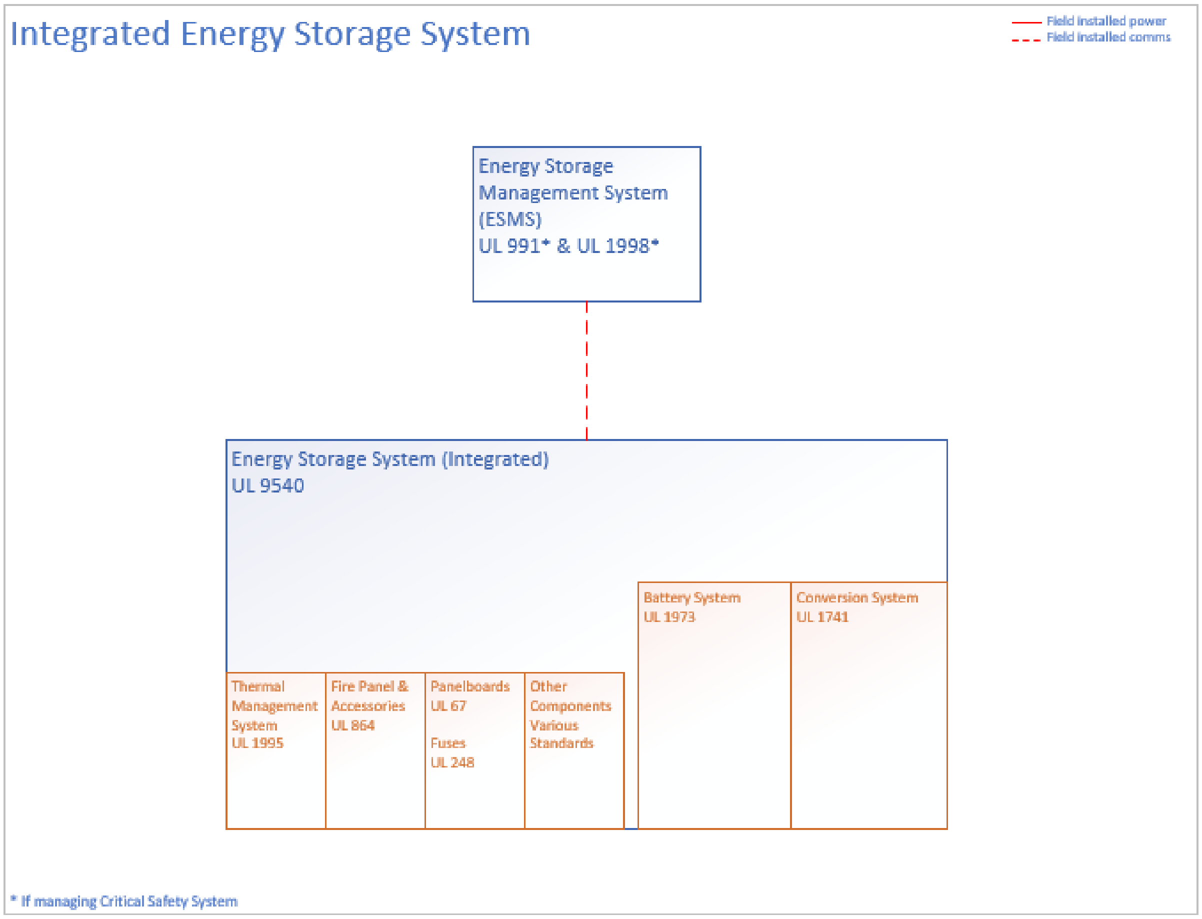
4.6.1.3 All Critical Safety Systems in 4.4.2.3 shall be included in at least one component listing and the equipment shall be listed and labeled for the Critical Safety System.

4.6.1.4 Software based Critical Safety Systems, as identified in 4.4.2.3, shall be listed for functional safety and software integrity via UL 991 and UL 1998.

A.4.6.1.1 Energy Storage System Types

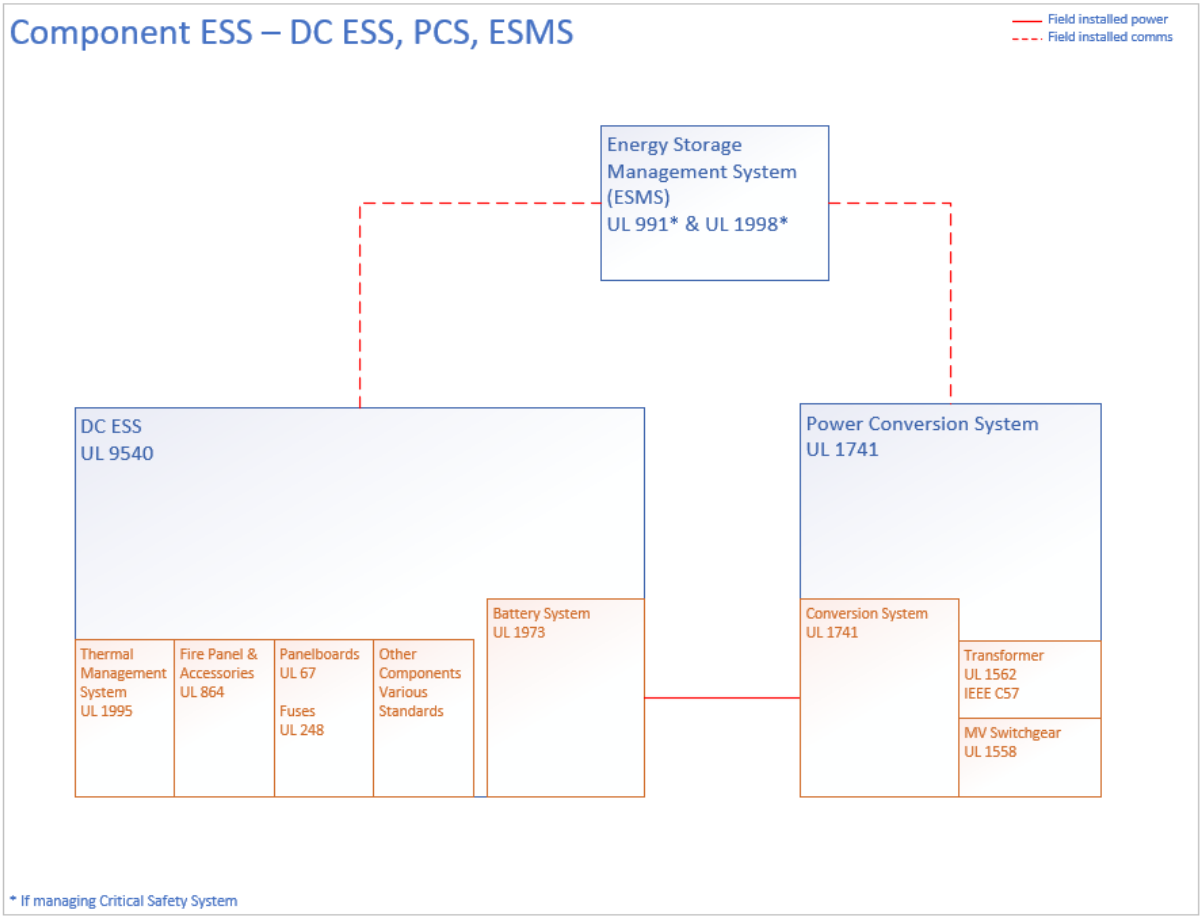
Integrated Energy Storage Systems

Fully integrated ESS, with battery system, integrated battery system controller, AC/DC protection, thermal management and PCS.



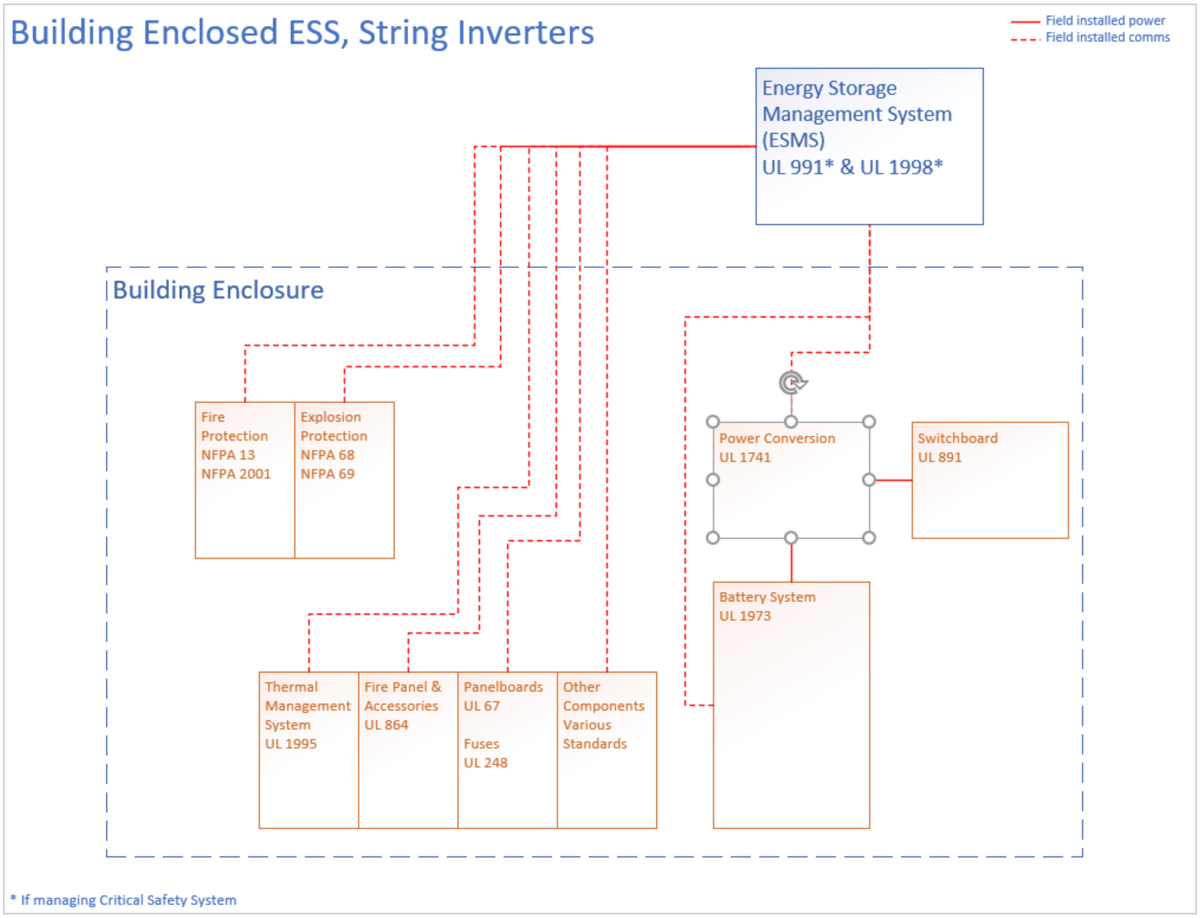
Component ESS – DC ESS, PCS and ESMS

Productized units from major suppliers. In most cases the integrator provides the integrated battery system and ESMS, with PCS supplied by an entity other than the integrator. The integrator will most likely wrap the supplied system. Owner may procure major components (IBS and PCS) directly.



Component ESS – Building Enclosed

Owner is procuring and integrating all major equipment. The enclosure is a purpose-built enclosure with all batteries residing in a single structure. Owner direct procurement of the battery system.



Stacked DC ESS or Battery Systems

Stacking of productized solutions in the field. The certification path remains the same. The systems must be tested per UL 9540A at the installation level with units adjacent to the primary unit, per the site layout or more intense.

Public Comment No. 11-NFPA 855-2024 [Section No. 4.6.3.1]

4.6.3.1*

Retrofits of ESSs shall ~~be approved and~~ comply with the following unless modified in other sections:

(1) Battery systems and modules and capacitor systems and modules shall be listed in accordance with UL 1973 and installed in accordance with the manufacturer’s instructions.

(2) ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer’s instructions.

(3) The overall installation shall continue to comply with UL 9540 listing requirements, where applicable.

(4) Retrofits shall be documented in the maintenance, testing, and events log required in 4.2.3.

Statement of Problem and Substantiation for Public Comment

If the Retrofit complies with all of the items in the list of 1 through 4, I don't think approval of the AHJ, as indicated by the words "shall be approved" are necessary or add additional value. Compliance with the list should suffice.

Related Item

- FR-99

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 12-NFPA 855-2024 [Section No. 4.6.10]

~~**4.6.10** * – Energy Storage Management System (ESMS).~~

~~Where required elsewhere in this standard, areas containing ESSs shall be provided with an ESMS or BMS, unless modified in Chapters 9 through 13 .~~

Statement of Problem and Substantiation for Public Comment

This text can come out of section 4. If it is required elsewhere, it is required elsewhere. Chapter 9 requires them. Chapters 10, 12 and 13 do not. Chapter 11 does for Fuel Cells, but since fuel cells don't store energy, I this is perhaps a mistake. If truly applicable it should be explicitly noted in chapter 11.

Related Item

- FR-66

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Public Comment No. 321-NFPA 855-2024 [Section No. 4.7]

4.7 Installation.

ESSs shall be installed in accordance with their listing, the manufacturer's installation instructions, and this standard.

4.7.1

When an ESS is installed in a structure, it shall be installed in a dedicated location readily accessible to first responders.

4.7.2* Electrical Installation.

The electrical installation shall be in accordance with *NFPA 70* or IEEE C2 based on the location of the ESS in relation to and its interaction with the electrical grid.

4.7.2.1

Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76 shall not be required to comply with 4.7.2.

4.7.2.2

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.7.2.

4.7.3 Seismic Protection.

ESSs shall meet seismic requirements in accordance with the applicable building codes.

4.7.4 Design Loads.

The weight of the ESS and all associated equipment, components, and enclosure elements and their impact on the dead and live loads of the building or system foundation shall be in accordance with the local building code.

4.7.5* Signage.

4.7.5.1

Approved signage shall be provided in the following locations:

(1) On the front of doors to rooms or areas containing ESSs or in approved locations near entrances to ESS rooms

(2) On the front of doors to outdoor occupiable ESS containers

(3) In approved locations on outdoor ESSs that are not enclosed in occupiable containers or otherwise enclosed

4.7.5.2*

The signage required in 4.7.5.1 shall be in compliance with ANSI Z535 and include the following information as shown in Figure 4.7.5.2:

(1) “Energy Storage Systems” with symbol of lightning bolt in a triangle

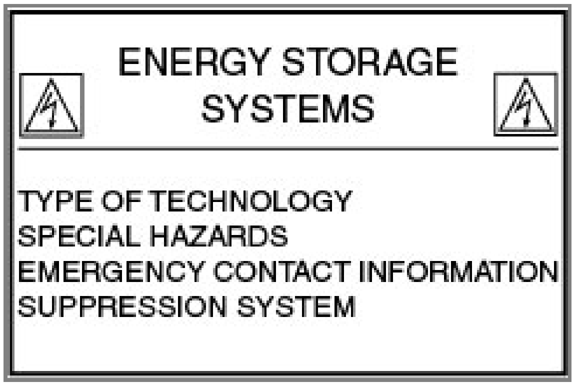
(2) Type of technology associated with the ESS

(3) Special hazards associated as identified in Chapters 9 through 15

(4) Type of suppression system installed in the area of the ESS

(5) Emergency contact information

Figure 4.7.5.2 Example of ESS Signage.



4.7.5.3

A permanent plaque or directory denoting the location of the disconnecting means for all ESSs on or in the premises shall be installed at each service equipment location and at the location(s) of the system disconnect(s) for all ESSs capable of being interconnected.

4.7.5.3.1

Energy storage located on property that is under the exclusive control of electric utilities, secured from public access, and in accordance with 90.2(D)(5) of *NFPA 70* shall not be required to comply with 4.7.5.3.

4.7.5.3.2

Lead-acid and nickel-cadmium battery systems less than 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations and secured from public access shall not be required to comply with 4.7.5.3.

4.7.5.4

Existing ESSs shall be permitted to retain the signage required at installation except as modified by 4.7.5.5.

4.7.5.5

Existing ESS signage shall be updated to comply with the requirements for new ESS installations when the system is retrofitted or existing signs need to be replaced.

4.7.5.6

Battery and ESS cabinets in occupied work centers covered by 9.5.1.2.1 shall be provided with exterior signs that identify the manufacturer and model number of the system and electrical rating (voltage and current) of the contained system, and any relevant electrical, chemical, and fire hazard.

4.7.6 Impact Protection.

4.7.6.1

ESSs shall be located or protected to prevent physical damage from impact where such risks are identified.

4.7.6.2

Vehicle impact protection consisting of guard posts or other approved means shall be provided where ESSs are subject to impact by motor vehicles.

4.7.6.3*

When guard posts are installed, they shall be designed as follows:

(1) Posts shall be constructed of steel not less than 4 in. (100 mm) in diameter.

(2) Posts shall be filled with concrete.

(3) Posts shall be spaced not more than 4 ft (1.2 m) on center.

(4) Posts shall be set not less than 3 ft (0.9 m) deep in a concrete footing of not less than 15 in. (380 mm) diameter.

(5) The top of the posts shall be set not less than 3 ft (0.9 m) above ground.

(6) Posts shall be located not less than 3 ft (0.9 m) from the ESS.

4.7.6.4*

For residential garages, ESSs shall not be installed in a location where subject to damage from impact by a motor vehicle.

4.7.7 Security of Installations.

4.7.7.1

ESSs shall be secured against unauthorized entry and safeguarded in an approved manner.

4.7.7.2

Security barriers, fences, landscaping, and other enclosures shall not inhibit the required air flow to or exhaust from the ESS and its components.

4.7.8 Elevation.

ESSs shall be located only on floors that can be accessed by external fire department laddering capabilities unless a higher location is approved by the AHJ.

4.7.8.1 Belowgrade Installations.

4.7.8.1.1

ESS installations where the floor level is below the finished floor of the lowest level of exit discharge shall not be permitted unless the location is approved by the AHJ.

4.7.8.1.2

When approved by the AHJ, ESS installations in underground vaults constructed in accordance with Part III of Article 450 of *NFPA 70* shall be permitted.

4.7.8.2

When approved by the AHJ, ESS installations on rooftops of buildings that do not obstruct fire department rooftop operations shall be permitted.

4.7.8.3

The requirements in 4.7.8 shall apply lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less.

4.7.9 Means of Egress.

4.7.9.1

All areas containing ESSs shall provide egress from the area in which they are located in accordance with the local building code.

4.7.9.2

Required egress doors shall be provided with emergency lighting as required by the local building code.

4.7.9.3

Required egress door(s) shall open in the direction of egress.

4.7.9.4

Required egress doors shall be equipped with listed panic hardware.

4.7.10 Open Rack Installations.

Where installed in a room accessible only to authorized personnel, ESSs shall be permitted to be installed on an open rack.

4.7.11 Fire Command Centers.

In buildings containing ESSs and equipped with a fire command center, the command center shall include signage or readily available documentation that describes the locations and types of ESSs, operating voltages, and locations of electrical disconnects where provided.

4.7.12 Access Roads.

Fire department access roads shall be provided to outdoor ESS installations in accordance with the local fire code.

4.7.13* Hazardous (Classified) Locations.

The ESS shall not be located in a classified area as defined in *NFPA 70* or IEEE C2 unless listed and approved for the specific installation.

4.7.14 Fire Barriers.

Rooms or spaces containing ESSs shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating and constructed in accordance with the local building code, unless modified in Chapters 9 through 13.

4.7.15 Oil- Insulated Equipment Spatial Seperation

ESSs located outdoors shall be seperated from oil-insulated equipment to minimize the impact of a major fire.

Statement of Problem and Substantiation for Public Comment

Equipment and buildings should be separated from oil-insulated equipment to minimize the impact of a major fire. The spatial separation between the electrical equipment and oil-insulated equipment should be taken from the equipment edge to the anticipated flame front for large, >500 gallons (1,900 liters), oil-filled equipment. The grid transformers are typically the largest oil-insulated equipment found in an electrical substation with a typical oil capacity of 3,000 – 7,000 gallons (11,400 – 26,500 liters). Reference NFPA 850, FMDS 5-3, and IEEE 979

Related Item

- First Revision No. 64-NFPA 855-2023

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 40-NFPA 855-2024 [Section No. 4.7.2]

4.7.2* Electrical Installation.

The electrical installation shall be in accordance with *NFPA 70* or IEEE C2 based on the location of the ESS in relation to and its interaction with the electrical grid.

4.7.2.1–

~~Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under~~

*

ESS installations serving as standby power while part of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such ~~installations that are in compliance with NFPA 76 shall~~ installations shall not be required to comply with 4.7.2.

*A. 4.7.2.

~~2~~

1 These installations are not covered by the NEC.

4.7.2.2*

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.7.2.

*A.4.7.2.2 These installations are not covered by the NEC.

Statement of Problem and Substantiation for Public Comment

NFPA 70 is very explicit that communications equipment batteries are part of the communications equipment and when under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations, these installations are OUTSIDE of the NEC. Full stop and irrespective of battery chemistry, battery voltage and compliance with NFPA 76, the NEC does not cover these installations. Having exemptions in NFPA 855 regarding application of NFPA 70, that conflict with the scope of NFPA 70, by limiting the exemption to certain voltages, chemistries and compliance with NFPA 76 is confusing for those who need to apply the standard. Having said that: If at a telecommunications site, a telecom carrier wants to install an ESS for purposes other than standby power for the telecom equipment, say for peak-shaving or harnessing of wind-power, that would not be a standby power application, would not be considered telecom equipment and would fall under the scope of the NEC. The proposed exemption is limited to standby power for this reason.

Annex material is added to both telecom and electric utility exemption to explain why these installations are exempted in NFPA 855, based on the scope of NFPA 70.

Related Item

- PI-113

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 206-NFPA 855-2024 [Sections 4.7.2.1, 4.7.2.2]

Sections 4.7.2.1, 4.7.2.2

4.7.2.1*

~~Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under~~ ESS installations consisting of standby power as part of communications equipment under the exclusive control of communications utilities ~~and~~ located outdoors or in building spaces used exclusively for such ~~installations that are in compliance with NFPA 76 shall~~ installations shall not be required to comply with 4.7.2.

A 4.7.2. 1 These installations are not covered by the NEC or IEEE C2.

4.7. 2.2*

~~Lead-acid and nickel-cadmium battery systems that~~ ESS installations that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to comply with 4.7.2.

A 4.7.2.2 These installations are not covered by the NEC or IEEE C2.

4.7.2.3*

ESS installations that are part of installations of railways for generation, transformation, transmission, energy storage, or distribution of power use exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes shall not be required to comply with 4.7.2 .

A 4.7.2.3 These installations are not covered by the NEC or IEEE C2.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium and other exemptions more consistent. The edits in this section are to properly align the exemptions for telecom, electric utility and rail with the scope of NFPA 70 and IEEE C2. NFPA 70 specifically notes these installations are not covered.

Related Item

- TG 24

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Submittal Date:	Tue May 28 08:19:41 EDT 2024
Committee:	ESS-AAA

Public Comment No. 128-NFPA 855-2024 [Section No. 4.7.5.1]

4.7.5.1

Approved signage shall be provided in the following locations:

(1) On the front of doors to rooms or areas containing ESSs or in approved locations near entrances to ESS rooms

(2) On the front of doors to outdoor occupiable ESS containers <u>or in approved locations near ESS site entrances</u>

(3) In approved locations on outdoor ESSs that are not enclosed in occupiable containers or otherwise enclosed

Statement of Problem and Substantiation for Public Comment

Signage is appropriate at site entraces/gated entrances of outdoor ESS installations

<u>Related Item</u>

- First Revision No. 61-NFPA 855-2023 [Section No. 4.7.2]

Submitter Information Verification

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Submittal Date: Wed May 22 17:20:54 EDT 2024

Committee: ESS-AAA

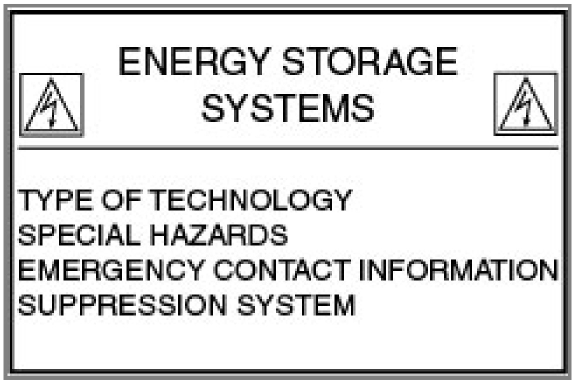
Public Comment No. 130-NFPA 855-2024 [Section No. 4.7.5.2]

4.7.5.2*

The signage required in 4.7.5.1 shall be in compliance with ANSI Z535 and include the following information as shown in Figure 4.7.5.2:

(1) “Energy Storage Systems” with symbol of lightning bolt in a triangle
(2) Type of technology associated with the ESS
(3) Special hazards associated as identified in Chapters 9 through 15
(4) Type of suppression system installed in the area of the ESS(if applicable)
(5) Type of explosion prevention system installed in the area of the ESS(if applicable)
(6) Emergency contact information

Figure 4.7.5.2 Example of ESS Signage.



Statement of Problem and Substantiation for Public Comment

Suppression may not be installed
Adding first responder information for explosion mitigation system present

Related Item

- First Revision No. 61-NFPA 855-2023 [Section No. 4.7.2]

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Submittal Date: Wed May 22 17:24:08 EDT 2024
Committee: ESS-AAA

Public Comment No. 208-NFPA 855-2024 [Section No. 4.7.5.3]

4.7.5.3

A permanent plaque or directory denoting the location of the disconnecting means for all ESSs on or in the premises shall be installed at each service equipment location and at the location(s) of the system disconnect(s) for all ESSs capable of being interconnected.

4.7.5.3.1*

Energy storage located on property that is under the exclusive control of electric utilities, secured from public access, and in accordance with 90.2(D)(5) of *NFPA 70* shall not be required to comply with 4.7.5.3.

A 4.7.5.3.

~~2~~

~~Lead-acid and nickel-cadmium battery systems less than 60 V dc in telecommunications facilities for installations of communications equipment under~~ 1 These installations are not covered by the NEC.

4.7.5.3.2*

Energy storage location on property that is under the exclusive control of communications utilities ~~and located outdoors or in building spaces used exclusively for such installations and secured from public access~~ , secured from public access, and in accordance with 90.2(D)(4) of *NFPA 70* shall not be required to comply with 4.7.5.3 .

A 4.7.5.3.2 These installations are not covered by the NEC.

4.7.5.3.3*

Energy storage operated as part of railways, secured from public access, and in accordance with 90.2(D)(3) of *NFPA 70* shall not be required to comply with 4.7.5.3.

A 4.7.5.3.3 These installations are not covered by the NEC.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make electric utility and telecom exemptions more consistently align with the scope of the NEC where the NEC is being referenced or inferred and add rail exemption similar to telecom and electric utility.

Related Item

- TG 24

Submitter Information Verification

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Submittal Date:	Tue May 28 08:49:18 EDT 2024
Committee:	ESS-AAA

Public Comment No. 41-NFPA 855-2024 [Section No. 4.7.5.3]

4.7.5.3

A permanent plaque or directory denoting the location of the disconnecting means for all ESSs on or in the premises shall be installed at each service equipment location and at the location(s) of the system disconnect(s) for all ESSs capable of being interconnected.

4.7.5.3.1*

Energy storage located on property that is under the exclusive control of electric utilities, secured from public access, and in accordance with 90.2(D)(5) of *NFPA 70* shall not be required to comply with 4.7.5.3.

A. 4.7.5.3. 1 These installations are not covered by the NEC.

4.7.5.3. 2*

~~Lead-acid and nickel-cadmium battery systems less than 60 V dc in telecommunications facilities for installations of~~ ESS installations consisting of standby power as part of communications equipment under the exclusive control of communications ~~utilities and located~~ utilities located outdoors or in building spaces used exclusively for such ~~installations and secured from public access shall~~ installations and in accorance with 90.2(D)(4) of NFPA 70 shall not be required to comply with 4.7.5.3.

A. 4.7.5.3.2 These installations are not covered by the NEC.

Statement of Problem and Substantiation for Public Comment

NFPA 70 is very explicit that communications equipment batteries are part of the communications equipment and when under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations, these installations are OUTSIDE of the NEC. Irrespective of battery chemistry, battery voltage and compliance with NFPA 76, the NEC does not require disconnects on communications equipment and communications standby batteries are so essential to communications equipment operation, they rarely are installed with disconnects due to reliability concerns. Having an exemption in NFPA 855 regarding disconnect signage, that implies certain telecom installations based on voltage or chemistries or lack of compliance with NFPA 76 will provide disconnects for standby batteries is misleading and will confuse enforcing authorities. Having said that: If at a telecommunications site, a telecom carrier wants to install an ESS for purposes other than standby power for the telecom equipment, say for peak-shaving or harnessing of wind-power, that would not be a standby power application, would not be considered telecom equipment and would fall under the scope of the NEC and may include a disconnect and related signage. The proposed exemption is limited to standby power for this reason.

Annex material is added to both telecom and electric utility exemption to explain why these installations are exempted in NFPA 855, based on the scope of NFPA 70.

Related Item

- FR-62

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Fri Mar 15 09:23:18 EDT 2024
Committee: ESS-AAA

Public Comment No. 129-NFPA 855-2024 [Section No. 4.7.5.3.1]

4.7.5.3.1

Energy storage located on property that is under the exclusive control of electric utilities <u>or balancing authority</u> , secured from public access, and in accordance with 90.2(D)(5) of *NFPA 70* shall not be required to comply with 4.7.5.3.

Statement of Problem and Substantiation for Public Comment

Many large ESS facilities are not under the control of the electric utility directly but instead are being dispatched by a balancing authority. These large ESS under the control of the balancing authority are serving critical grid functions to maintain the reliability of the grid and should not be completely disconnected if a portion of the ESS facility can be isolated and the rest is operated safely. These facilities controlled by the balancing authority should fall under the same rules as one being controlled by the electric utility for the same reasons this exclusion was included.

<u>Related Item</u>

- FR 62

Submitter Information Verification

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Submittal Date: Wed May 22 17:22:59 EDT 2024
Committee: ESS-AAA

Public Comment No. 42-NFPA 855-2024 [Section No. 4.7.8]

4.7.8 Elevation.

ESSs shall be located only on floors that can be accessed by external fire department laddering capabilities unless a higher location is approved by the AHJ.

4.7.8.1 Belowgrade Installations.

4.7.8.1.1

ESS installations where the floor level is below the finished floor of the lowest level of exit discharge shall not be permitted unless the location is approved by the AHJ.

4.7.8.1.2

When approved by the AHJ, ESS installations in underground vaults constructed in accordance with Part III of Article 450 of *NFPA 70* shall be permitted.

4.7.8.2

When approved by the AHJ, ESS installations on rooftops of buildings that do not obstruct fire department rooftop operations shall be permitted.

4.7.8.3 .

The requirements in 4.7.8 shall not apply to traditional standby power applications.

4.7.8.4

The requirements in 4.7.8 shall not apply to lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less.

Statement of Problem and Substantiation for Public Comment

Presently there are 15 or so exemptions, many with slightly different wording to address telecom, electric utility and UPS applications. First goal is to make these exemptions more consistent. Second goal: while UL 1973 was updated in 2022 to better address lead-acid and nickel-cadmium batteries, there are presently few or no UL 1973 listed flooded lead acid and nickel-cadmium batteries on the market. Removing the exemption in place in the 2023 edition and replacing it with a new exemption language that relies in products not available is damaging to the users of flooded cells that have a very good safety record with respect to traditional standby power. It would be best to maintain two exemption paths – one for listed batteries and one for traditional standby power.

Related Item

- FR-145

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Fri Mar 15 09:24:16 EDT 2024

Committee: ESS-AAA

Public Comment No. 159-NFPA 855-2024 [Section No. 4.7.8.3]

4.7.8.3

The requirements in 4.7.8 shall not apply to lead-acid and nickel-cadmium batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(6) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located .

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Related Item

- TG-24

Submitter Information Verification

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Submittal Date: Fri May 24 17:34:45 EDT 2024
Committee: ESS-AAA

Public Comment No. 323-NFPA 855-2024 [Section No. 4.7.8.3]

4.7.8.3

The requirements in 4.7.8 shall not apply to vented lead-acid ~~and~~ batteries, nickel-cadmium, or valve-regulated lead-acid (VRLA) batteries listed to UL1973, installed in systems ~~600 V dc~~ 1500 Vdc or less.

Statement of Problem and Substantiation for Public Comment

Vented lead-acid and nickel-cadmium batteries are being considered as excluded from stationary standby power requirements as covered in Public Comment 121 and TG 24 recommendations. This distinction is necessary to ensure that AHJ's and regulatory bodies understand the distinction of a vented lead-acid cell (or vented nickel cadmium cell) from the more common VRLA or 'sealed' nickel-cadmium batteries. Note: This ties into FR 126. VRLA lead-acid batteries will now be listed to UL1973 which ensures that these batteries have been tested and proven safe to meet NFPA 855 and UL 9540 requirements, 1500 Vdc is now the standard limit for many applications using lead-acid batteries. The NEC have moved the low voltage limit to 1500 Vdc from 600 Vdc.

Related Item

• FR 126 • PC 121

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 66-NFPA 855-2024 [Section No. 4.7.8.3]

4.7.8.3

The requirements in 4.7.8 shall not apply to lead-~~acid and~~ acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less.

Statement of Problem and Substantiation for Public Comment

The FR is as captured eliminates ANY elevation exemption for these batteries by removing the word "not". None of the three PIs in this section sought this change, and the Committee Statement related to the FR does not explain it, so it seems to be a small but serious typographical error. Other PCs may address other changes to this text, but as a minimum the word "not" should be restored.

Related Item

- FR-145

Submitter Information Verification

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Submittal Date: Mon Mar 18 16:17:35 EDT 2024
Committee: ESS-AAA

Public Comment No. 13-NFPA 855-2024 [Section No. 4.7.14]

~~**4.7.14** – Fire Barriers.~~

~~Rooms or spaces containing ESSs shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating and constructed in accordance with the local building code, unless modified in Chapters 9 through 13 .~~

Statement of Problem and Substantiation for Public Comment

This text can come out of section 4. It is more clearly required in Chapter 9. Chapters 10, 12 and 13 do not specify fire rated separations. Chapter 11 does not explicitly call out this requirement but it should.

Related Item

- PI-149

Submitter Information Verification

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Submittal Date: Tue Mar 12 21:02:23 EDT 2024
Committee: ESS-AAA

Public Comment No. 14-NFPA 855-2024 [Section No. 4.8.1]

~~**4.8.1**~~ ~~*~~ –

~~Where required elsewhere in this standard, areas containing ESSs shall be provided with a smoke detection, thermal image fire detection, or radiant-energy-sensing system in accordance with *NFPA 72* , unless modified by the requirements in Chapters 9 through 13 .~~

Statement of Problem and Substantiation for Public Comment

If required elsewhere, these items are required elsewhere and need not be considered in section 4.

Related Item

- FR-181

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Tue Mar 12 21:13:34 EDT 2024
Committee: ESS-AAA

Public Comment No. 346-NFPA 855-2024 [New Section after 4.8.2.2]

4.8.2.2.1

Fire command center, or other approved location, shall have a map or graphic annunciator installed showing the following information:

(1) Name of building or business

(2) Address of building or business

(3) North arrow

(4) Fire alarm symbol legend

(5) Date when map/graphic annunciator was installed or last updated

(6) “You are here” symbol to orient fire personnel with their location

(7) Room numbers/names for ESS installed in buildings

(8) Equipment numbers/IDs for ESS installed outdoors

(9) Point identification, or reference legend, for each initiating device, or approved summary alarms from multiple initiating devices

Statement of Problem and Substantiation for Public Comment

Where there are either large buildings with ESS or large ESS facilities that end up requiring a fire command center, a map or graphic annunciator would be valuable to first responders to quickly identify where the point of failure has occurred. Some ESS facilities can have hundreds or thousands of alarms and using a typical FACP or annunciator it can be difficult to quickly correlate the alarm ID to where the alarm is physically on site.

Related Item

- FR 43

Submitter Information Verification

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Submittal Date: Thu May 30 17:02:26 EDT 2024
Committee: ESS-AAA

Public Comment No. 132-NFPA 855-2024 [Section No. 4.9]

4.9 Fire Control and Suppression.

4.9.1*

Where required elsewhere in this standard, fire control and suppression for rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided in accordance with this section, unless modified in Chapters 9 through 13.

4.9.1.1

When approved by the AHJ, ESSs shall be permitted to be installed in open parking garages without the protection of an automatic fire suppression system where fire, explosion, and fault condition testing documents the system does not present an exposure hazard to parked vehicles when installed in accordance with manufacturer’s instructions and this standard.

4.9.1.2

When approved by the AHJ, ESSs shall be permitted to be installed in ESS dedicated-use buildings without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard to buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.

4.9.1.3

When approved by the AHJ, ESSs shall be permitted to be installed in outdoor walk-in enclosures without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard in accordance with 9.5.2.6.1 and 9.5.2.6.1.7.

4.9.2 Sprinkler System.

Sprinkler systems shall be installed in accordance with NFPA 13 or equivalent.

4.9.2.1

Sprinkler systems for ESS units (groups) with a maximum stored energy of 50 kWh, as described in 9.4.2.1, shall be designed using a minimum density of 0.3 gpm/ft^2 (12.2 mm/min) based over the area of the room or 2500 ft^2 (230 m^2) design area, whichever is smaller, unless a lower density is approved based upon fire and explosion testing in accordance with 9.1.5.

4.9.2.2*

Sprinkler systems for ESS units (groups) exceeding 50 kWh shall use a density based on fire and explosion testing in accordance with 9.1.5.

4.9. 2. 3

Water based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25.

Water

4.9.3 Alternate Automatic Fire Control and Suppression Systems.

4.9.3.1*

Other automatic fire control and suppression systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5.

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 15

(2) NFPA 750

4.9.4 Water Supply.

4.9.4.1*

Where required elsewhere in this standard, sites where nonmechanical ESSs are installed shall be provided with a permanent source of water for fire protection, unless modified in Chapters 9 through 13.

4.9.4.2

Where no permanent adequate and reliable water supply exists for firefighting purposes, the requirements of NFPA 1142 shall apply.

4.9.4.3

Accessible fire hydrants shall be provided for site ESS installations where a public or private water supply is available.

4.9.4.4

Fire hydrants installed on private fire service mains shall be installed in accordance with NFPA 24 or equivalent local requirement where NFPA 24 is not adopted.

<u>**4.9.5**</u>

<u>A fire suppression system design review should be performed by a registered design professional for any new site or modification to an existing fire suppression system.</u>

<u>4.9.5.1</u>

<u>The design review may include:</u>

<u>1) Water Supply Graph</u>

<u>2) Fire Hydrant Flow Test</u>

<u>3) System Hydraulic Calculations</u>

Statement of Problem and Substantiation for Public Comment

Addition of installation, testing, and maintenance reference to NFPA 25
Addition of appropriate design review to ensure system piping and calculations are adequate

Related Item

- Public Input

Submitter Information Verification

Submitter Full Name: Chris Groves
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Submittal Date: Wed May 22 18:00:55 EDT 2024
Committee: ESS-AAA

Public Comment No. 80-NFPA 855-2024 [Section No. 4.9]

4.9 Fire Control ~~and Suppression.~~ , Suppression, and Thermal Runaway Protection

4.9.1*

Where required elsewhere in this standard, fire control and suppression for rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided in accordance with this section, unless modified in Chapters 9 through 13.

4.9.1.1

When approved by the AHJ, ESSs shall be permitted to be installed in open parking garages without the protection of an automatic fire suppression system where fire, explosion, and fault condition testing documents the system does not present an exposure hazard to parked vehicles when installed in accordance with manufacturer's instructions and this standard.

4.9.1.2

When approved by the AHJ, ESSs shall be permitted to be installed in ESS dedicated-use buildings without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard to buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.

4.9.1.3

When approved by the AHJ, ESSs shall be permitted to be installed in outdoor walk-in enclosures without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard in accordance with 9.5.2.6.1 and 9.5.2.6.1.7.

4.9.2 Sprinkler System.

Sprinkler systems shall be installed in accordance with NFPA 13 or equivalent.

4.9.2.1

Sprinkler systems for ESS units (groups) with a maximum stored energy of 50 kWh, as described in 9.4.2.1, shall be designed using a minimum density of 0.3 gpm/ft^2 (12.2 mm/min) based over the area of the room or 2500 ft^2 (230 m^2) design area, whichever is smaller, unless a lower density is approved based upon fire and explosion testing in accordance with 9.1.5.

4.9.2.2*

Sprinkler systems for ESS units (groups) exceeding 50 kWh shall use a density based on fire and explosion testing in accordance with 9.1.5.

4.9.3 Alternate Automatic Fire Control ~~and Suppression Systems~~ , Suppression, and Thermal Runaway Protection Systems .

4.9.3.1*

Other automatic fire control and suppression ~~systems~~ , and thermal runaway protection systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5.

4.9.3. ~~2~~ 2 Thermal Runaway Protection Systems applied directly to battery modules shall be accompanied by an installed fire suppression or control system for the room.

4.9.3.3 *

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 15

(2) NFPA 750

4.9.4 Water Supply.

4.9.4.1*

Where required elsewhere in this standard, sites where nonmechanical ESSs are installed shall be provided with a permanent source of water for fire protection, unless modified in Chapters 9 through 13.

4.9.4.2

Where no permanent adequate and reliable water supply exists for firefighting purposes, the requirements of NFPA 1142 shall apply.

4.9.4.3

Accessible fire hydrants shall be provided for site ESS installations where a public or private water supply is available.

4.9.4.4

Fire hydrants installed on private fire service mains shall be installed in accordance with NFPA 24 or equivalent local requirement where NFPA 24 is not adopted.

Statement of Problem and Substantiation for Public Comment

Addition of this text will recognize thermal management systems and also recognize that a these systems do not replace a fire control or suppression system for the room in which an ESS is installed.

Related Item

- FR-45

Submitter Information Verification

Submitter Full Name: Brad Stilwell
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Submittal Date: Tue Apr 02 13:43:42 EDT 2024
Committee: ESS-AAA

Public Comment No. 311-NFPA 855-2024 [Section No. 4.9.1]

4.9.1*

Where required elsewhere in this standard, fire control and suppression for rooms or areas within ~~buildings and outdoor walk-in units containing~~ buildings containing ESSs shall be provided in accordance with this section, unless modified in Chapters 9 through 13.

4.9.1.1

When approved by the AHJ, ESSs shall be permitted to be installed in open parking garages without the protection of an automatic fire suppression system where fire, explosion, and fault condition testing documents the system does not present an exposure hazard to parked vehicles when installed in accordance with manufacturer's instructions and this standard.

4.9.1.2

When approved by the AHJ, ESSs shall be permitted to be installed in ESS dedicated-use buildings without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard to buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.

~~**4.9.1.3**~~ –

~~When approved by the AHJ, ESSs shall be permitted to be installed in outdoor walk-in enclosures without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard in accordance with 9.5.2.6.1 and 9.5.2.6.1.7 .~~

Statement of Problem and Substantiation for Public Comment

This proposal is part of a series of proposals deleting requirements targeting walk-in units. The only reason for the walk-in unit sections was to treat them the same as a building for fire protection requirements, primarily fire suppression. The installation of the fire suppression is not practical and is contrary to the requirement that large-scale fire testing document a unit can be consumed by fire and not propagate to other ESS units.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 316-NFPA 855-2024 [Sections 9.5.3.1.4.1, 9.5.3.1.4.2]	
Public Comment No. 319-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 320-NFPA 855-2024 [Section No. 9.6.2.1]	
Public Comment No. 322-NFPA 855-2024 [Sections 9.3.1.2, 9.3.1.3]	

Related Item

• CI-185 • FR-46

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Submittal Date: Thu May 30 14:02:26 EDT 2024
Committee: ESS-AAA

Public Comment No. 15-NFPA 855-2024 [Section No. 4.9.1 [Excluding any Sub-Sections]]

~~Where required elsewhere in this standard, fire~~ Fire control and suppression for rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided in accordance with this section, unless modified in Chapters 9 through 13.

Statement of Problem and Substantiation for Public Comment

Simplified wording. "Where required elsewhere" adds no value.

Related Item

- PI-162

Submitter Information Verification

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Submittal Date:	Tue Mar 12 21:15:38 EDT 2024
Committee:	ESS-AAA

Public Comment No. 184-NFPA 855-2024 [Section No. 4.9.1 [Excluding any Sub-Sections]]

Where required elsewhere in this standard, fire control and suppression for rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided in accordance with this section, unless modified in Chapters 9 through ~~13~~ 17 .

Statement of Problem and Substantiation for Public Comment

Editorial update. Addition of new chapters requires an update.

Related Item

- FR 108

Submitter Information Verification

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Submittal Date: Mon May 27 11:37:45 EDT 2024
Committee: ESS-AAA

Public Comment No. 16-NFPA 855-2024 [Sections 4.9.1.1, 4.9.1.2]

~~Sections 4.9.1.1, 4.9.1.2~~

~~4.9.1.1~~ –

~~When approved by the AHJ, ESSs shall be permitted to be installed in open parking garages without the protection of an automatic fire suppression system where fire, explosion, and fault condition testing documents the system does not present an exposure hazard to parked vehicles when installed in accordance with manufacturer's instructions and this standard.~~

~~4.9.1.2~~ –

~~When approved by the AHJ, ESSs shall be permitted to be installed in ESS dedicated-use buildings without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard to buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure.~~

Statement of Problem and Substantiation for Public Comment

These are already covered nearly word for word in 9.5.3.1.4.3 and 9.5.1.1.1. They can come out of Chapter 4.

Related Item

- FR-44

Submitter Information Verification

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Submittal Date: Tue Mar 12 21:18:29 EDT 2024
Committee: ESS-AAA

Public Comment No. 17-NFPA 855-2024 [Section No. 4.9.1.3]

~~4.9.1.3~~ –

~~When approved by the AHJ, ESSs shall be permitted to be installed in outdoor walk-in enclosures without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 documents that an ESS fire does not compromise the means of egress and does not present an exposure hazard in accordance with 9.5.2.6.1 and 9.5.2.6.1.7 .~~

Statement of Problem and Substantiation for Public Comment

This text should be relocated to Chapter 9 with the other Battery ESS exceptions, perhaps after 9.6.2.2.4.

Related Item

- FR-44

Submitter Information Verification

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Submittal Date: Tue Mar 12 21:21:17 EDT 2024
Committee: ESS-AAA

Public Comment No. 179-NFPA 855-2024 [Section No. 4.9.3]

4.9.3 ~~Alternate~~ Optional Automatic Fire Control and Suppression Systems.

4.9.3.1*

Other automatic fire control and suppression systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5.

4.9.3.2*

The optional automatic fire control and suppression systems shall comply with the following standards, or their equivalent, ~~as appropriate~~ unless modified in chapters 9 through 17 :

(1) NFPA 15

(2) NFPA 750

Statement of Problem and Substantiation for Public Comment

As this section is meant to apply to all chapters. Fire control and suppression systems are not "alternate" but optional is a better term. Other chapters may modify them in accordance with the technology.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 180-NFPA 855-2024 [Section No. 4.9.3.1]	

Related Item

- FR 45

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Street Address:
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Submittal Date: Mon May 27 11:05:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 180-NFPA 855-2024 [Section No. 4.9.3.1]

4.9.3.~~1~~ 2 *

Other automatic fire control and suppression systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5.

Statement of Problem and Substantiation for Public Comment

Moving "other fire control and suppression" to below typical type systems as this is an option to listed system by testing and not the main requirement.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 179-NFPA 855-2024 [Section No. 4.9.3]	
Public Comment No. 181-NFPA 855-2024 [Section No. A.4.9.3.1]	

Related Item

- FR 45

Submitter Information Verification

Submitter Full Name: Paul Hayes
Organization: The Hiller Companies/American
Street Address:
City:
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Zip:
Submittal Date: Mon May 27 11:09:47 EDT 2024
Committee: ESS-AAA

Public Comment No. 178-NFPA 855-2024 [New Section after 4.9.3.2]

4.9.3.3* Fire Control and suppression systems used for Thermal Runaway Protection shall meet the requirements of section 9.6.6.5.3

A.4.9.3.3 Thermal Runaway Protection may utilize traditional suppression mythology's that are normally compliant to NFPA codes, however the modification of these system to provide heat management other than fire suppression, makes them non-compliant to the traditional NFPA codes. Effectiveness of alternate technologies for TR are to be tested specifically to the application for reliability and survivability.

Statement of Problem and Substantiation for Public Comment

It is not clean the application of NFPA compliant systems vs the use of these system for TRPS that are not always compliant to the NFPA code but can provide some mitigation against single cell failures. Addition points back to CHpater 9 and how these systems should be applied.

Related Item

- FR 45

Submitter Information Verification

Submitter Full Name:	Paul Hayes
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Submittal Date:	Mon May 27 10:55:08 EDT 2024
Committee:	ESS-AAA

Public Comment No. 101-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 12

(2) NFPA 15

(3) NFPA 750

(4) NFPA 770

(5) NFPA 2001

(6) NFPA 2010

Additional Proposed Changes

File Name	Description	Approved
PVEL_FINAL_REPORT_ESS_Aerosol_-_30_Aug_2021.pdf	Substantiation support for adding back NFPA 2010 in particular - test report stating aerosol effectiveness in mitigating risk of TR propagation in LIB TR or fire events	

Statement of Problem and Substantiation for Public Comment

Current substantiation for removal of the 4 standards states, "Other fire control and suppression have not been shown to effectively control lithium battery fires except NFPA 15 and NFPA 750 systems.

1. This substantiation only addresses LIB fires. The NFPA 855 standard is intended to address multiple types of battery technology within ESS enclosures. This substantiation referencing only LIB fires cannot be used to remove all NFPA standards originally referenced from the standard intended to address many types of battery technologies within ESS enclosures.

2. Further, in the case of NFPA 2010, data has been presented to the TG on fire suppression and explosion protection, clearly indicating that aerosol systems are IN FACT effective in controlling lithium ion battery fires. Based on this, the substantiation is not accurate, and at a minimum NFPA 2010 should be returned into the body of the document. Hard copy of the referenced report will be sent based on instructions as part of the Public Comment process

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 103-NFPA 855-2024 [Section No. 9.6.2]	

Related Item

- Proposed change to 4.9.3.2 made by the committee

Submitter Information Verification

Submitter Full Name: Lance Harry

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Street Address:
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Submittal Date: Mon May 13 14:59:21 EDT 2024
Committee: ESS-AAA

UL9540A Unit Level Test Report

Final Report
Fireaway Inc.

ESS & Stat-X FSS

Report No.: R5097D-1

Date: 30 August 2021

Customer: Fireaway Inc.
Customer Contact: Anthony Gee
Date of issue: 30 August 2021
Project No.: 5097

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Reference to part of this report which may lead to misinterpretation is not permissible.

Revision	Date	Reason for Issue	Prepared by	Verified by	Approved by
1	30 August 2021	Initial Draft	Beryl Weinshenker	John Watts	John Watts

Table of Contents

1 Test setup

1.1. Introduction

The following is a test report on the UL9540A (Edition 4, dated November 12, 2019) Unit Level testing performed on 14 May 2021. The test was performed at 9300 OH-66, Piqua, Ohio 45356 on a mock-up of a Battery Energy Storage Solution (BESS) fitted with the Fireaway Stat-X fire suppression system (FSS). An excerpt of the NRTL Report is included in Section 2.2 of this Report. The NRTL Report indicates the test was in accordance with UL9540A Section 9.3, as well as the additional measurements detailed in Section 1.5.1.

This Report defines: the BESS and FSS tested, the construction of the mock-up BESS enclosure, gas measurement equipment, electrical measurement equipment, and test procedures. The actual energy storage solution is a standalone BESS packaged in a “20ft Hi-Cube” shipping container (exterior dimensions: 20’x8’x9.5’). An image of the representative BESS solution is shown in Figure 1 below as reference.

Figure 1 Battery Energy Storage Solution

Please note that in an effort to improve accuracy, the mock-up BESS test enclosure was approximately half the 20ft Hi-Cube length.

As indicated in Section 2 of this Report, the Stat-X FSS provided fire suppression from 2,726 seconds (FSS discharge) to 3,015 seconds (enclosure ventilation). During this time, the FSS seemed to inhibit any flaming combustion, and no temperature spikes were observed.

This Report includes the NRTL Report’s compliance tables in Section 2.2, with maximum gas concentrations listed towards the end of Section 2.2.

PVEL notes that at 3,015 seconds the enclosure was ventilated “when a potential of explosion [was] observed within the testing enclosure with high concentration[s] of vented gases”.

Figure 2 details the battery modules in the BESS rack assemblies. Figure 3 details the battery modules in the mock-up test enclosure.

Figure 2 BESS rack/module assembly (19 modules and 2 BPU converters per rack)

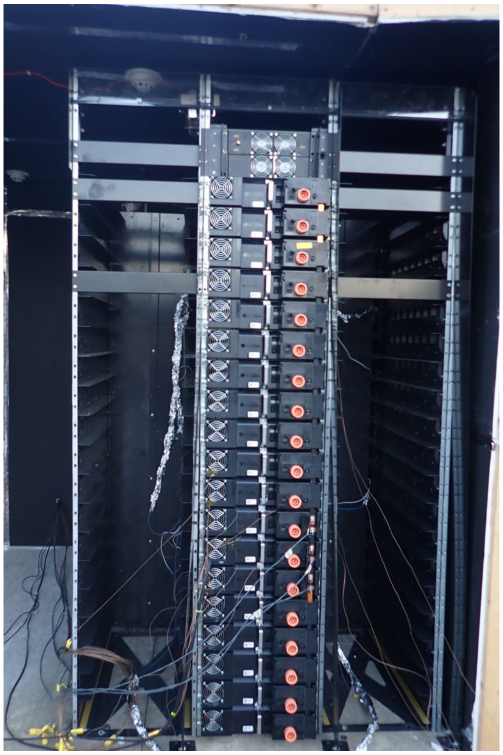

Figure 3 Test enclosure’s rack/module assembly (initiating rack and adjacent target racks)

1.2. Product Specifications

The following lists the technical specifications of the components evaluated by the UL9540A test.

1.2.1. Cells LG JH4 Pouch Lithium Li-ion chemistry (NMC)

The cells tested have the following technical specifications:

- Voltage = 3.67 V (nominal)
- Capacity = 72.5 Ah
- Mass = 1170 g (2.6 lbs)
- Dimensions = 100 mm x 353 mm x 16 mm

Figure 4 shows the film heater attached to the LG JH4 cell.

Figure 4 JH4 Cell with Installed Flexible Film Heater

1.2.2. Modules

The modules tested include (42) JH4 cells and have the following technical specifications:

- Voltage = 51.8 V
- Capacity = 290 Ah
- Mass = 88.6 kg (195 lbs)
- Dimensions = 445 mm (without mounting bracket) x 979 mm (with MSD plug) x 110 mm.

Figure 5 shows a rendered image of the LG module.

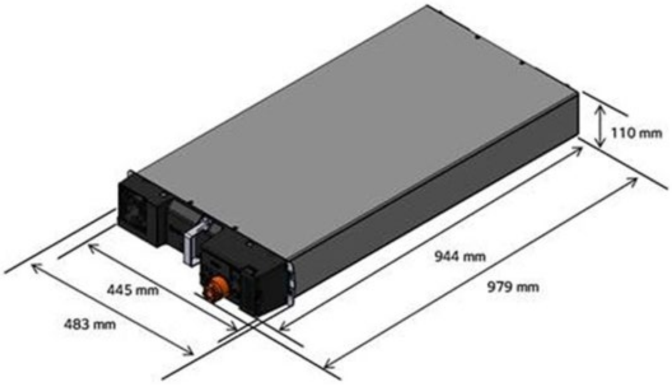

Figure 5 LG Chem 3P Module

1.3. Racks

Each rack contains 19 LG modules. In order to account for the various racking layouts in a deployed BESS, the racks in the test enclosure were configured as 3-linked rack configuration abutting and centered behind a single rack. The center rack of the 3-linked rack is the initiating rack, and the other racks are the target racks. Figure 6 shows this rack configuration.

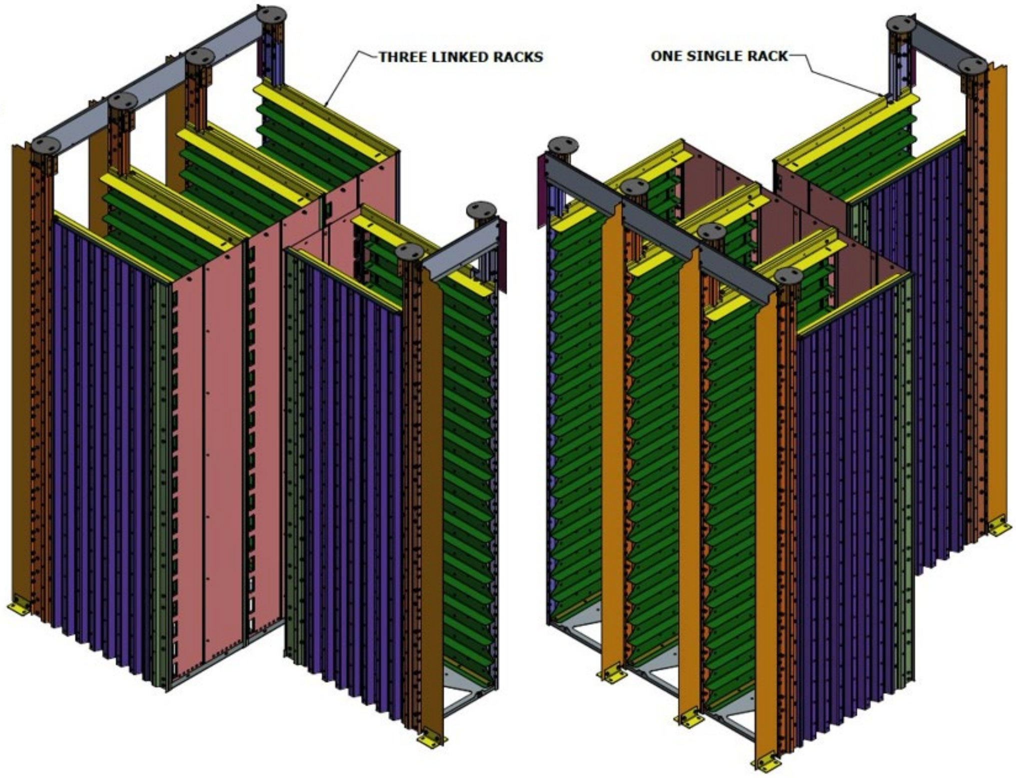

Figure 6 Rack layout from front side (right) and back side (left)

The dimensions of the racks are as follows:

- Width = 1568 mm (61 ¾") (for the 3-linked)
- Height = 2614 mm (102 15/16")
- Depth = 911 mm (35 7/8")

1.3.1. Fire Suppression System

- Stat-X® Aerosol Fire Suppression System
    - Potter Electric PFC-4410RC fire alarm control panel
    - Potter manual release pull station
    - Stat-X model = 500E
    - Number of Stat-X model 500E devices = 4
    - Locations of Stat-X model 500E devices = See Figure 7 below

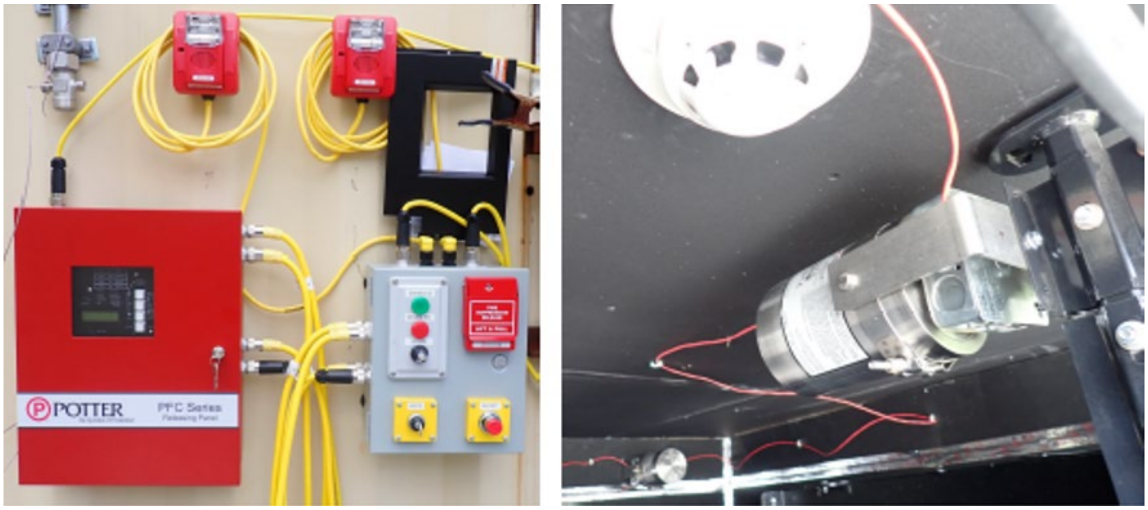

Figure 7 Integrated Stat-X fire suppression system. Stat-X monitoring and activation system (left). Stat-X generator and smoke detector (right).

    - Aerosol Mass = 500g
    - Weight = 3.4 kg ±5%
    - Total Length = 205 mm (including the ¾” threaded coupling)
    - Diameter = 127 mm
    - Approximate Discharge Time = 23.0 seconds
    - Initiation current = 0.5 amps in parallel; 1.0 amps in series
    - Releasing circuit pulse = 50 milliseconds
    - Maximum Supervisory Current = 0.005 amps (on release circuit)

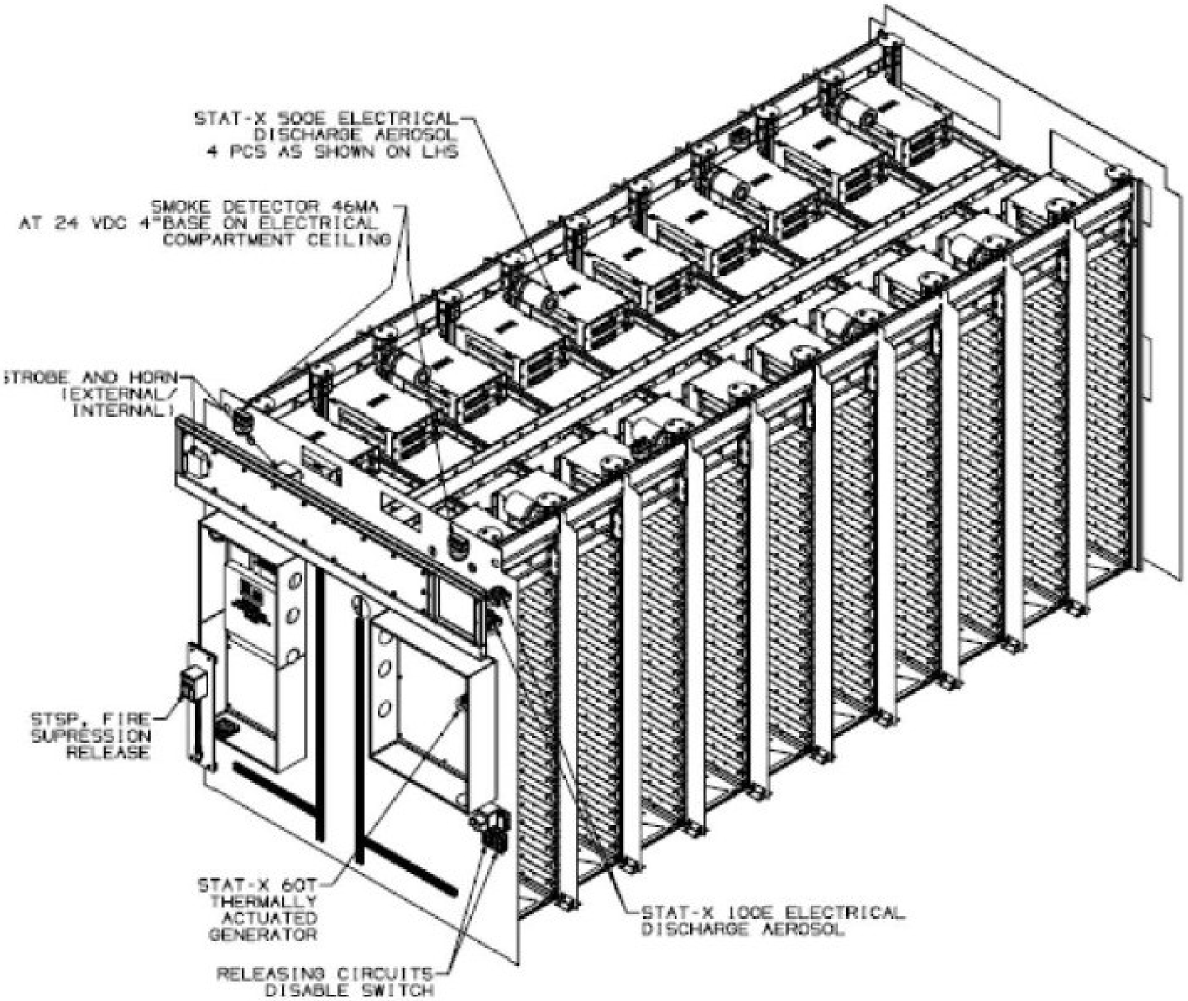

Figure 8 Stat-X Aerosol Fire Suppression Layout in an actual BESS application (test enclosure was half the length)

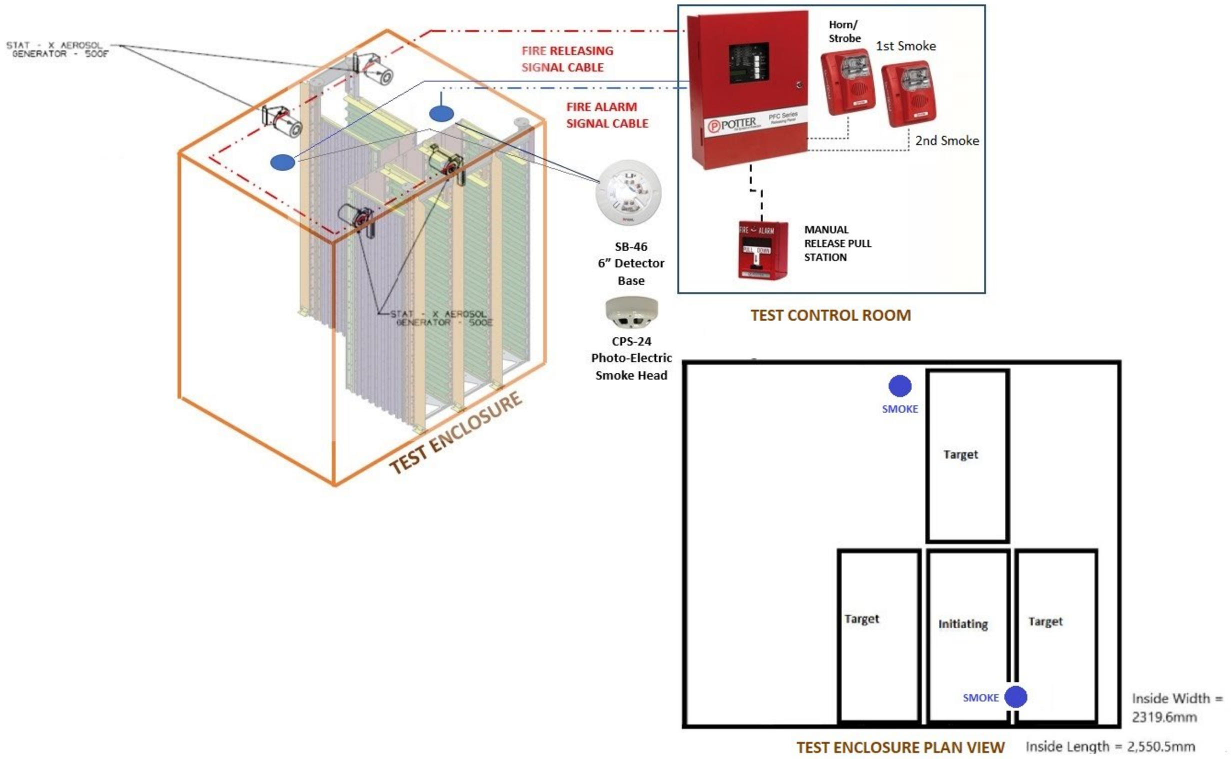

Figure 9 Stat-X Aerosol Fire Suppression Layout within the mock-up test enclosure

1.4. Definition of Unit and Test Philosophy

The BESS racks are capable of interlocking side to side as well as back-to-back. For this unit level test, the testing team installed 19 modules with 2 BPU converters in the center rack (initiating rack), and adjacent unpopulated target racks on each side. In addition, an unpopulated single rack was intertied to the initiating rack in a back-to-back fashion. The unpopulated target racks used sheet metal instead of modules.

All modules in the initiating rack were topped off at MOSOC within 8 hours of the testing start time. The initiation method was film heaters on the initiating cell inside the module. The initiating rack contained 19 modules. Monitoring equipment was installed as per UL9540A in all target units.

1.5. Unit Level Test Configuration

The unit level testing required construction of one mockup test enclosure intended to simulate a real-world application, and in which an internal fire condition was initiated. The mock-up enclosure also included target racks that were representative of adjacent racks in a BESS installation. The mock-up test enclosure was built as per the detailed container dimensions provided by GE provided.

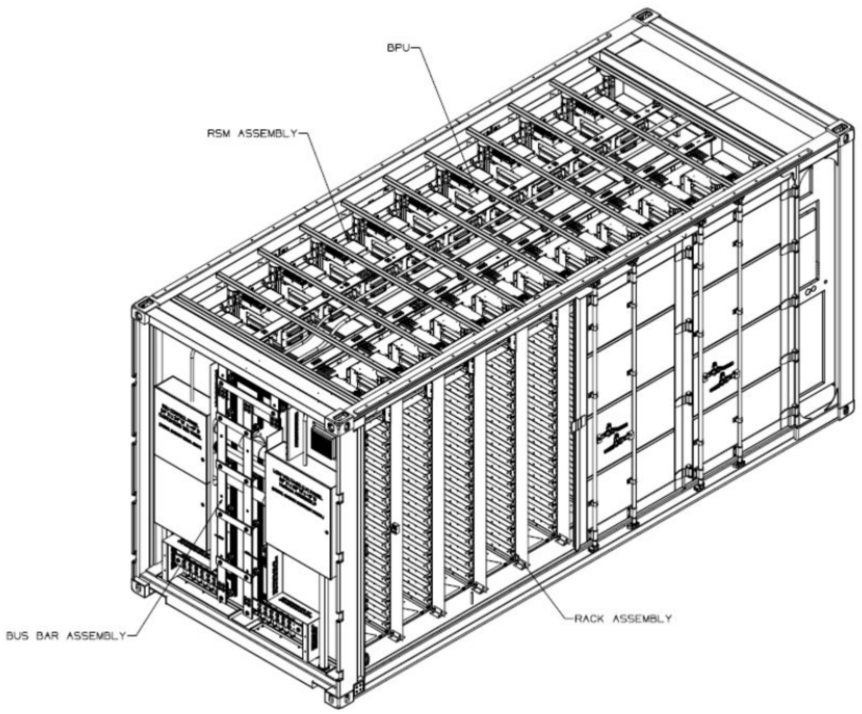

Figure 10 BESS container – isometric view (actual container shown; test enclosure will be half the length)

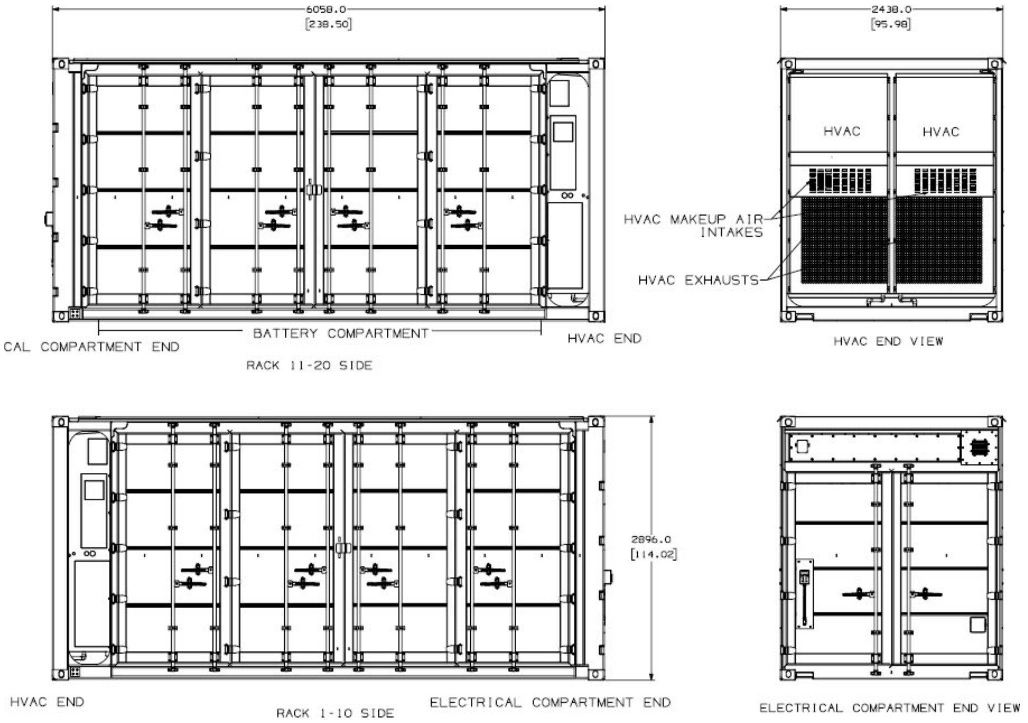

Figure 11 Actual BESS Container Exterior Dimensions (actual container shown; test enclosure will be half the length)

To accomplish the BESS Unit Level Testing, the configuration shown in Figure 12 was utilized.

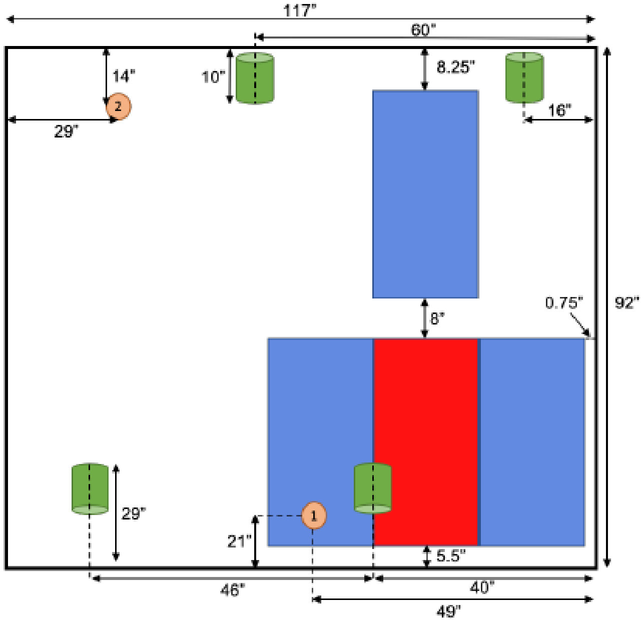

Figure 12 Test enclosure plan view. Initiating unit (red), target units (blue), Stat-X aerosol generators(green), and smoke detectors (orange).

<u>BESS Container Dimensions (inside </u>L x W x H): 2,550.5mm ±5mm x 2319.6mm ±3mm x 2640.7mm ±5mm

Figure 13 Mock-up test enclosure with the front wall in place (right) and without the front wall in place (left)

The distances (rack to rack, and racks to walls) materially aligned with the BESS solution. The testing team installed the instrument in the front and side walls as required by UL9540A edition 4.

For test purposes, a total of 4 GE racks will be utilized. The locations of the racks, in terms of distance from the drywall on the front side, aligned with the intended installation. All distances between racks aligned with the intended installation. Heat flux gauges were utilized to understand the thermal properties of the initiation module and rack on neighboring target modules and rack.

PVEL notes that the illustrations provided in Figure 9.1 of UL9540A are examples, and are not intended to exclude other realistic representations, such as the one proposed in this Report.

<u>Further considerations for testing:</u>

1. The initiating rack set contained all components representative of a BESS unit in a complete installation. (This includes all materials, components, cabling, etc.)
2. The target back rack contained all components representative of a BESS unit in a complete installation, with the exception of being unpopulated with respect to modules (i.e. sheet metal was used instead of modules).
3. The target side racks contained all components representative of a BESS unit in a complete installation, with the exception of being unpopulated with respect to modules (i.e. sheet metal was used instead of modules).
4. Heat flux gauges were placed throughout the setup in line with UL9540A requirements.
5. The initiating modules was at maximum operating state of charge (MOSOC), in accordance with the manufacturer's specifications, for conducting the tests in this recommended practice.
6. After charging, the test was initiated within eight hours.
7. All components (enclosure, cabling, electronics, coolants, etc.) that were part of the complete BESS installation were positioned and connected as part of the test setup. The initiating BESS unit was in an operational state prior to testing. However, modification of the initiating module to allow for insertion of the film heaters took place as required and resulted in altered bus bars.
8. The instrumented wall section consisted of 24ga (or smaller), bare end, "K" Type thermocouples placed every 6" colinear with the heat flux gauges. The instrumented wall section was painted black and was 12" in width running the full vertical height of the wall. The non-fire exposed side of the wall had thermocouples placed as appropriate to demonstrate fire resistance through the wall.

The custom fabrication of the mock-up test enclosure mimicked the BESS solution, while allowing for alternate rack configurations. The test team assured that there were no material "air leaks" in the construction, which could adversely impact the deployment of the Stat-X FSS. The enclosure included a rapidly removable roof in case of explosion or explosion risk. The walls of the enclosure were comprised of non-flammable masonry framed on 16" centered studded walls. As the fire rating of the walls was not the subject of testing, the walls were constructed of a single layer of gypsum board taped and plastered. Construction of the mock-up enclosure was a of single layer of (one hour rated) 5/8" Type-X drywall on 16" centered studs to simulate the masonry construction of a standard room layout. The instrumentation section of the walls was painted matte black in alignment with the UL 9540A requirements.

1.5.1. Measurements Plan

Table 1 Gas measurement and sampling plan

Measurement [1] [2]	Method	Measurement range	Sensor location	Measurement duration [3]
H_2 hydrogen	Palladium-nickel thin film solid state sensor	0.4 to 5.0 % vol.	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	Full duration of test
H_2 hydrogen	Catalytic hydrogensensor	0 to 4 % vol.	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	Full duration of test
CH_4 Total hydrocarbons	Flame ionization detection (FID)	0 to 30,000 ppm	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	Full duration of test
Container pressure	Multi-range differential pressure transducer array	0 to 10 inches of water	• Center of enclosure volume	From Thermal Runaway to Fire Suppression System Activation
Container average gas temperature	“TC tree” type-K thermocouples of size 24 AWG or larger)	0 to 1000C	• 3 to 5 measurement locations across the elevation of the center of the enclosure	From Thermal Runaway to Fire Suppression System Activation
O2 oxygen	Paramagnetic oxygen analyzer	0-100%vol	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	From Thermal Runaway to Fire Suppression System Activation
CO carbon monoxide	Nondispersive infrared carbon monoxide analyzer	0-3000ppm	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	From Thermal Runaway to Fire Suppression System Activation
CO2 carbon dioxide	Nondispersive infrared carbon dioxide analyzer	0-2000ppm	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	From Thermal Runaway to Fire Suppression System Activation
CO2 carbon dioxide	Nondispersive infrared carbon dioxide analyzer	0-5%vol	• 1” below the test enclosure ceiling. • Above the initiating rack, center rack of the triple linked rack	From Thermal Runaway to Fire Suppression System Activation

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1. Additional safety factors should be considered when the volumetric gas measurements are intended for life/safety applications. Determination of such safety factors is beyond the scope of this Test Plan or Final Report.
2. Please note: Accuracy of the volumetric gas measurements may be approximately ±50%. Factors that may affect this accuracy include: test enclosure integrity, gas leakage calibration, gas production rate and volume from failing BESS prior to FSS activation, and FSS activation time.
3. Activation of the Stat-X suppression system may impact the data collected. Further, based on the proposed placement of the suppression system, initiating device (2nd smoke detector), and anticipated early activation of the Stat-X system, the gas monitoring will likely be unableto detect the gas released from the cells if the number of thermal runaway / venting events is limited.

Table 2 Thermocouple and heat flux gage count per location

Section	Number of TCs
Front Instrumented Wall Section (IWS)	17 TCs
Lateral Instrumented Wall Section (IWS)	17 TCs
Left Lateral Unit	4 TCs outside, 2 TCs inside
Right Lateral Unit	4 TCs outside, 2 TCs inside
Rear Lateral Unit	4 TCs outside, 2 TCs inside
Ceiling Matrix	9 TCs
Internal	10 Heat Flux Gauges

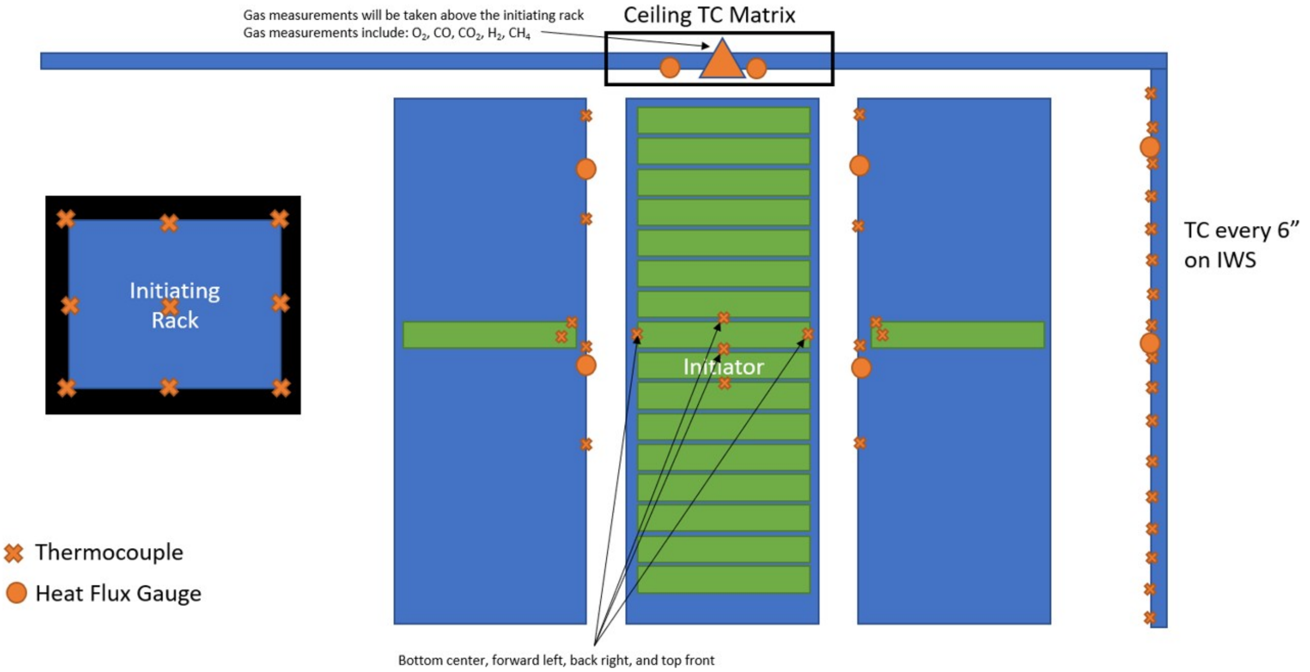


Figure 14 Orthographic (Multiview) Drawing of initiating rack and target racks. Location of instrumentation shown

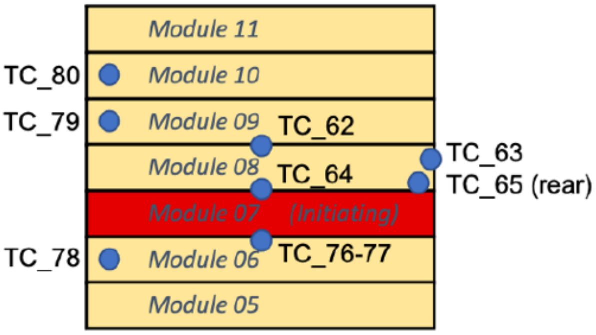
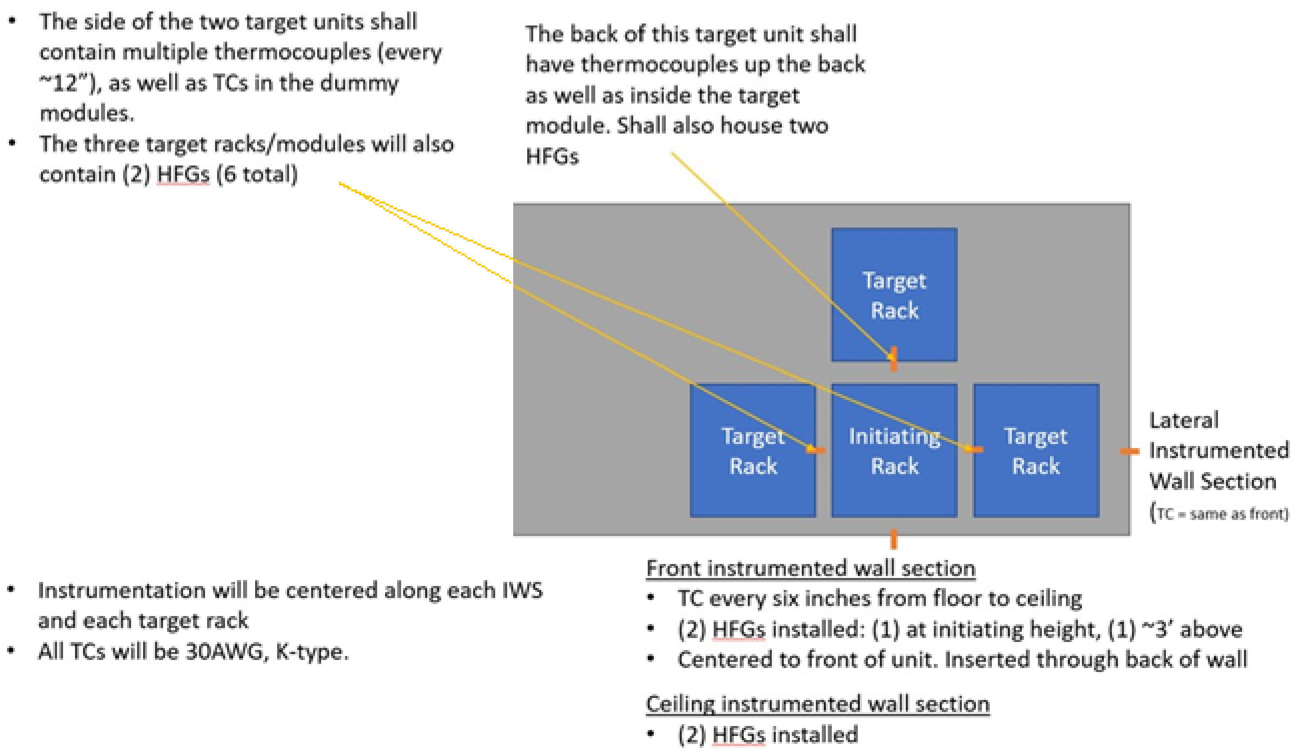


Figure 15 Instrumentation on the test unit



- The side of the two target units shall contain multiple thermocouples (every ~12"), as well as TCs in the dummy modules.
- The three target racks/modules will also contain (2) HFGs (6 total)

The back of this target unit shall have thermocouples up the back as well as inside the target module. Shall also house two HFGs

Lateral Instrumented Wall Section (TC = same as front)

- Instrumentation will be centered along each IWS and each target rack
- All TCs will be 30AWG, K-type.

Front instrumented wall section

- TC every six inches from floor to ceiling
- (2) HFGs installed: (1) at initiating height, (1) ~3' above
- Centered to front of unit. Inserted through back of wall

Ceiling instrumented wall section

- (2) HFGs installed

Figure 16 Thermocouple and heat flux plan for areas surrounding initiating rack

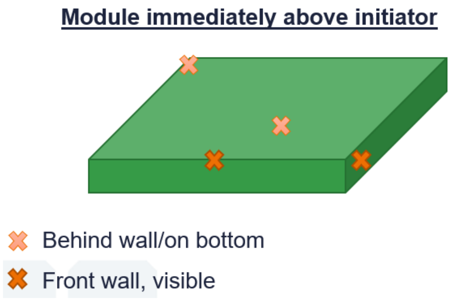


Figure 17 Location of thermocouples on module above the initiating module.

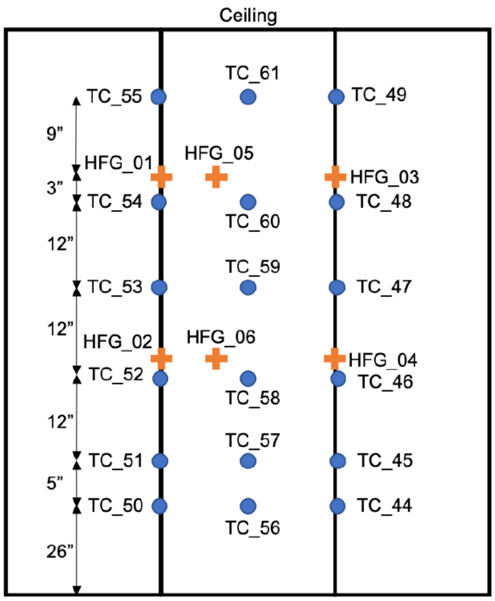


Figure 18 Instrumentation on the target racks viewed from the front

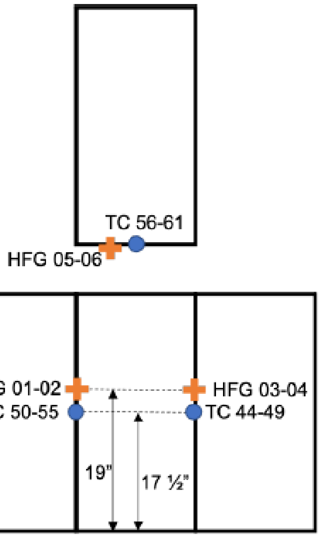


Figure 19 Instrumentation on the target racks from plan view.

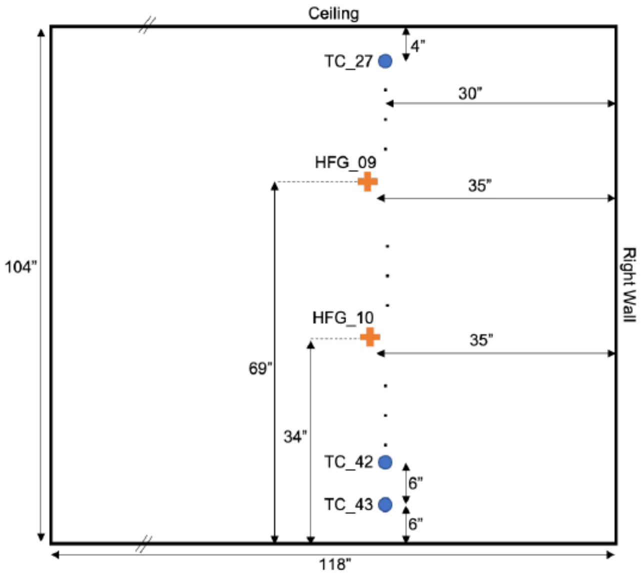


Figure 20 Instrumentation on the front wall viewed from the front of the structure.

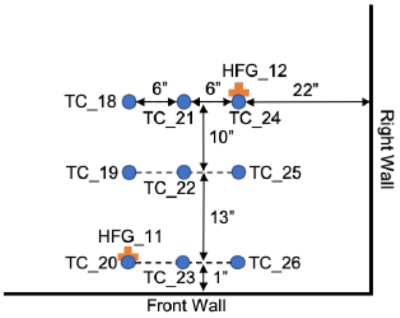


Figure 21 Instrumentation on the ceiling from plan view.

Additionally, a module mass measurement was performed (to the best of the testing team's abilities). Mass measurements for unit or installation level testing under the 4th edition of UL9540A are not required, but are recommended for test scenarios where module to module propagation is not anticipated. A calibrated scale was used for mass measurements of the initiating module. Mass measurements were taken before and after testing (the best of the testing team's abilities) to determine the mass loss of the selected initiating module to further demonstrate thermal runaway propagation or control.

1.5.2. Gas Production Rate

Additional measurements to approximate the gas volume produced by the thermal runaway event were included within the testing enclosure. This measurement approach sought to apply a qualitative methodology to determine the volume of each gas constituent (O2, CO, CO2, H2, and UHC) within the enclosure, from the time of thermal runaway until the activation of the fire suppression system. The measurements included the use of a multi-range differential pressure transducer array to measure the pressure of the enclosure over the identified period of time. Additionally, a thermocouple tree consisting of three to five measurement locations across the elevation of the enclosure was applied at the center of the enclosure volume to determine an average temperature of the gas within the enclosure, type-K thermocouples of size 24 AWG or larger were used. To determine the gas production, the approach applies the gross enclosure volume to perform calculations based on ideal gas law approximations.

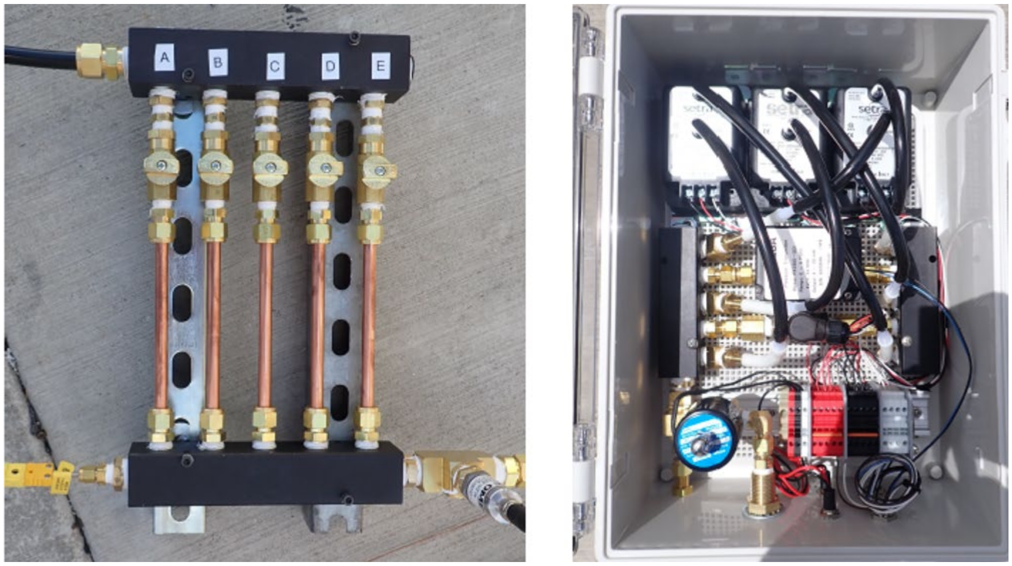


Figure 22 Pressure measurement apparatus: Flow control manifolds (left), and differential pressure transducer array (right)

The proposed measurement approach additionally applied a calibration to the enclosure using a mass flow controller to supply compressed air to the test volume at a flow rate of up to 100 SLPM, in order to determine a relationship between enclosure pressure and leakage rate. These calibrations were applied to the enclosure after completed instrumentation, and prior to testing. While concentration of the sampled gas can be determined in the period of interest by extracting a sample from the enclosure and evaluating the concentration of the identified gases, the calculation of the volume production is dependent upon a number of variables that may result in measurement uncertainties equal in magnitude to the measured quantities. Thus, the applicability of said measurement cannot be guaranteed, specifically for life safety applications. The factors affecting the accuracy of the proposed measurements include:

- Enclosure integrity
- Ability to characterize the gas leakage rate from the enclosure
- Gas production rate prior to fire suppression system activation
- Fire suppression system activation time

While every effort will be made to ensure measurements are collected in a scientifically rigorous manner, neither the level of accuracy, nor the applicably of said measurements, can be guaranteed.

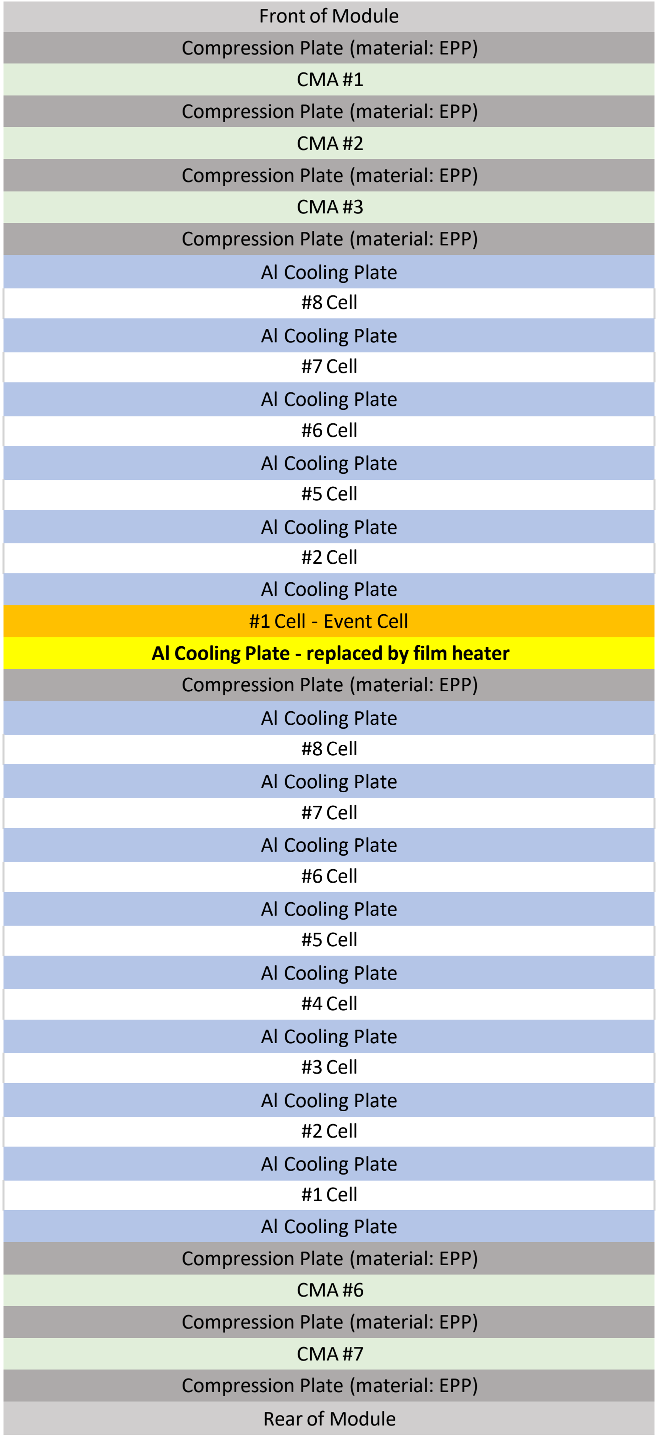
1.6. Testing Method

PVEL and its partners performed the Unit Level testing in accordance with the UL 9540A recommended test practice as outlined in Section 9.3 of UL9540A, plus the additional measurements detailed in herein.

a. This includes all setup requirements, standoff distances, and measurement criteria
b. The system was configured based on its final proposed configuration and test plan
c. Initiation took place via film heaters on cells in the initiating module.

1.6.1. Test Initiation

The initiating module was located in the seventh position in the rack, counting upwards. Prior to testing, the team brought all modules, including the initiating module, to full charge. Following the top-off charge, PVEL and the testing team instrumented the initiating module with film heaters in a similar fashion as described in the UL9540A module level testing report. It has been determined by both the Cell Level Report (UL LLC, 21 March 2019) and Module Level Report (UL LLC, 12 December 2018) that the JH4 cell can be reliably sent into thermal runaway using a single heater on one side of the JH4 cell. The (42) JH4 cells are configured in a 14S-3P configuration inside each module. A graphic showing the approximate film heater location is included in Figure 23. Note that the film heater replaced the cooling plate in the module layout. Also note that full charge prior to instrumenting the module was assured, since the cell electrodes were cut free from the bus bars in order to gain access to the cells for heater installation and thermocouple placement.



Front of Module
Compression Plate (material: EPP)
CMA #1
Compression Plate (material: EPP)
CMA #2
Compression Plate (material: EPP)
CMA #3
Compression Plate (material: EPP)
Al Cooling Plate
#8 Cell
Al Cooling Plate
#7 Cell
Al Cooling Plate
#6 Cell
Al Cooling Plate
#5 Cell
Al Cooling Plate
#2 Cell
Al Cooling Plate
#1 Cell - Event Cell
Al Cooling Plate - replaced by film heater
Compression Plate (material: EPP)
Al Cooling Plate
#8 Cell
Al Cooling Plate
#7 Cell
Al Cooling Plate
#6 Cell
Al Cooling Plate
#5 Cell
Al Cooling Plate
#4 Cell
Al Cooling Plate
#3 Cell
Al Cooling Plate
#2 Cell
Al Cooling Plate
#1 Cell
Al Cooling Plate
Compression Plate (material: EPP)
CMA #6
Compression Plate (material: EPP)
CMA #7
Compression Plate (material: EPP)
Rear of Module

Figure 23 Initiating Module Sample Layout

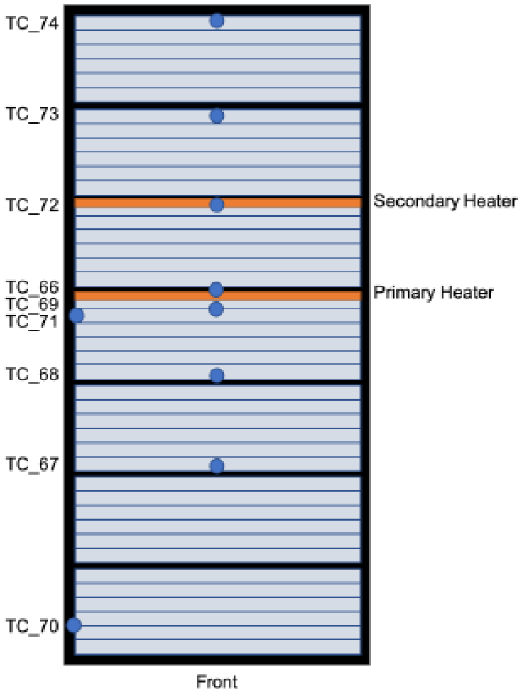


Figure 24 Section view of the initiating module with thermocouple placement

The team assured that all measurement equipment including both the electrical and gas analysis equipment were properly collecting and logging the data. Once confirmed, the team initiated the test by applying a voltage source capable of achieving a 5°C/min to 7°C/min heating rate of the initiating cell. Once the cell reached thermal runaway, the team immediately de-energized the film heaters. The initiation event was then monitored to understand cell to cell propagation, module to module propagation, and ultimately rack to rack propagation. All parameters required to be monitored by UL9540A were adhered to throughout the testing.

1.6.2. Fire Suppression Deployment

Deployment of the fire suppression system occurred per the following sequence of events (see Figure 25):

a. Smoke and off gassing from the initiating module triggered the two smoke detectors positioned over the initiating rack.
b. The PFC-4410RC panel annunciated the alarm condition (display panel, horn, strobe)
c. A 30 second countdown began; after 41 seconds, the Stat-X FSS manual pull station was activated to release the FSS.

The testing would terminate if:

a. Temperatures measured inside each module within the initiating BESS unit returned to ambient temperature; or
b. The fire propagated to the adjacent racks, walls; or
c. A condition hazardous to testing staff or the test facility required mitigation.

Figure 25 Stat-X Fire Suppression System Activation Sequence

1.7. Performance Requirements

As listed in UL9540A the following are the performance requirements of the testing:

1. The surface temperature of modules within the target BESS units adjacent to the initiating BESS unit shall not exceed the temperature at which thermally initiated cell venting occurs, as determined in the cell level tests.
2. Explosion hazards are not observed, including deflagration, detonation, or accumulation (to within the flammability limits) of battery vent gases.
3. For installation near exposures, surface temperature measurements on wall surfaces shall not exceed 97 °C of temperature rise above ambient.

1.8. Data Acquisition

A number of data acquisition requirements are imposed by UL9540A at the unit level. To satisfy these requirements, the team incorporated additional assistance from Fire Risk Alliance (FRA), who managed gas-based data acquisition requirements. Rescue Methods and their partners managed all video and IR video recording. NRTL verified the list of monitoring requirements with the team at least two weeks in advance of the testing date, to assure alignment with the governing recommended practice.

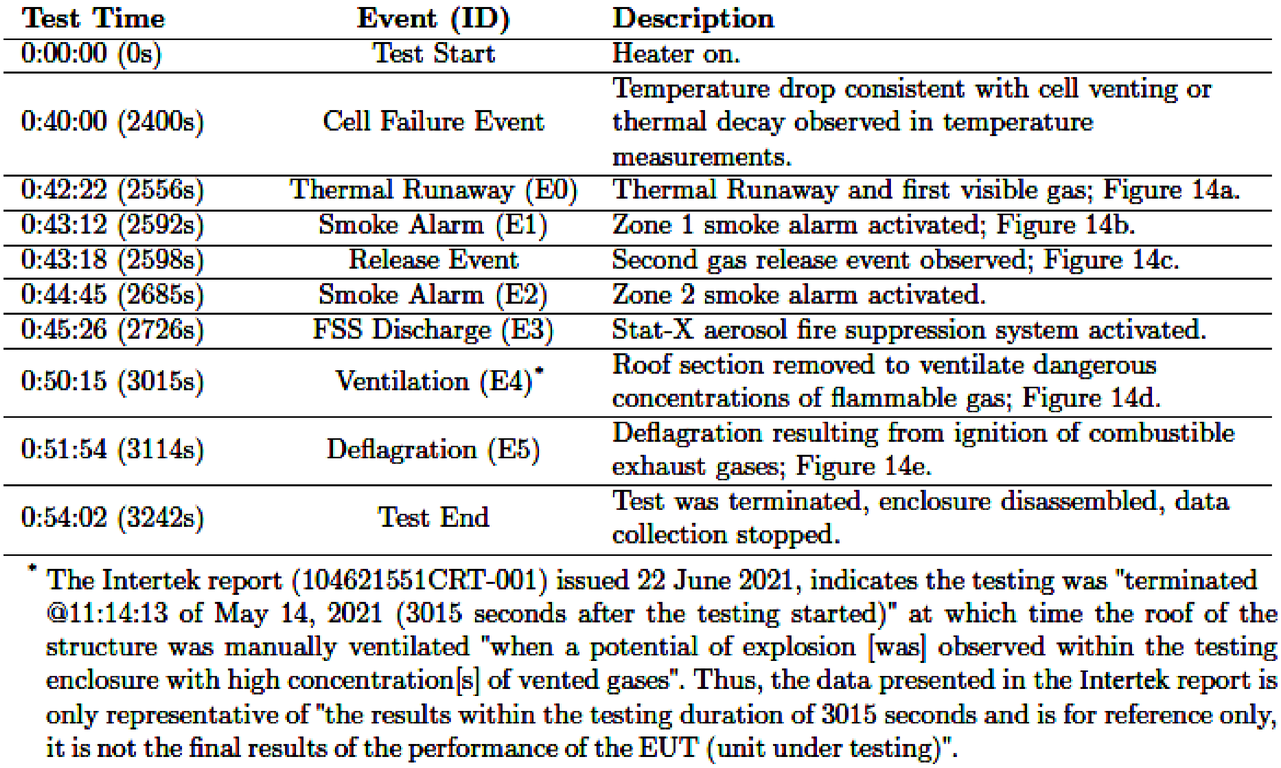
Version 4 of the Test Plan was signed by all parties: Fireaway, Intertek, BESS OEM, and PVEL. Version 5 of the Test Plan was approved by all parties via email confirmation.

2 Test Results Summary

2.1. Test results as reported by PVEL

Refer to PVEL test report R5097C-3 for details on test data.

Table 3 Overview of test timeline and key events



Test Time	Event (ID)	Description
0:00:00 (0s)	Test Start	Heater on.
0:40:00 (2400s)	Cell Failure Event	Temperature drop consistent with cell venting or thermal decay observed in temperature measurements.
0:42:22 (2556s)	Thermal Runaway (E0)	Thermal Runaway and first visible gas; Figure 14a.
0:43:12 (2592s)	Smoke Alarm (E1)	Zone 1 smoke alarm activated; Figure 14b.
0:43:18 (2598s)	Release Event	Second gas release event observed; Figure 14c.
0:44:45 (2685s)	Smoke Alarm (E2)	Zone 2 smoke alarm activated.
0:45:26 (2726s)	FSS Discharge (E3)	Stat-X aerosol fire suppression system activated.
0:50:15 (3015s)	Ventilation (E4)*	Roof section removed to ventilate dangerous concentrations of flammable gas; Figure 14d.
0:51:54 (3114s)	Deflagration (E5)	Deflagration resulting from ignition of combustible exhaust gases; Figure 14e.
0:54:02 (3242s)	Test End	Test was terminated, enclosure disassembled, data collection stopped.

* The Intertek report (104621551CRT-001) issued 22 June 2021, indicates the testing was "terminated @11:14:13 of May 14, 2021 (3015 seconds after the testing started)" at which time the roof of the structure was manually ventilated "when a potential of explosion [was] observed within the testing enclosure with high concentration[s] of vented gases". Thus, the data presented in the Intertek report is only representative of "the results within the testing duration of 3015 seconds and is for reference only, it is not the final results of the performance of the EUT (unit under testing)".

There are 3 distinct phases illustrated in the above table:

- Phase 1: E0 (start of thermal runaway) to E3 (activation of Stat-X)
- Phase 2: E3 (activation of Stat-X) to E4 (termination of test per the NRTL / enclosure ventilation)
- Phase 3: E4 (end of test per NRTL / start of free burn) to end of data collection

Figure 26, Figure 27, and Figure 28 show the temperature trends at the adjacent target racks, and indicate a temperature lower than 100°C, far below the free burn temperatures of the initiating unit, up to E4. Significant temperatures at the target units were only see after event E4, particularly after deflagration at event E4.

As shown in Figure 29, gas temperatures recorded at different elevations of the test enclosure were below 100°C (212°F) between the Stat-X FSS holding period between E3 and E4, 20 inches to 80 inches from the floor level. Propagation only occurred after the test enclosure was breached following event E5 ventilation, which also resulted in a deflagration event.

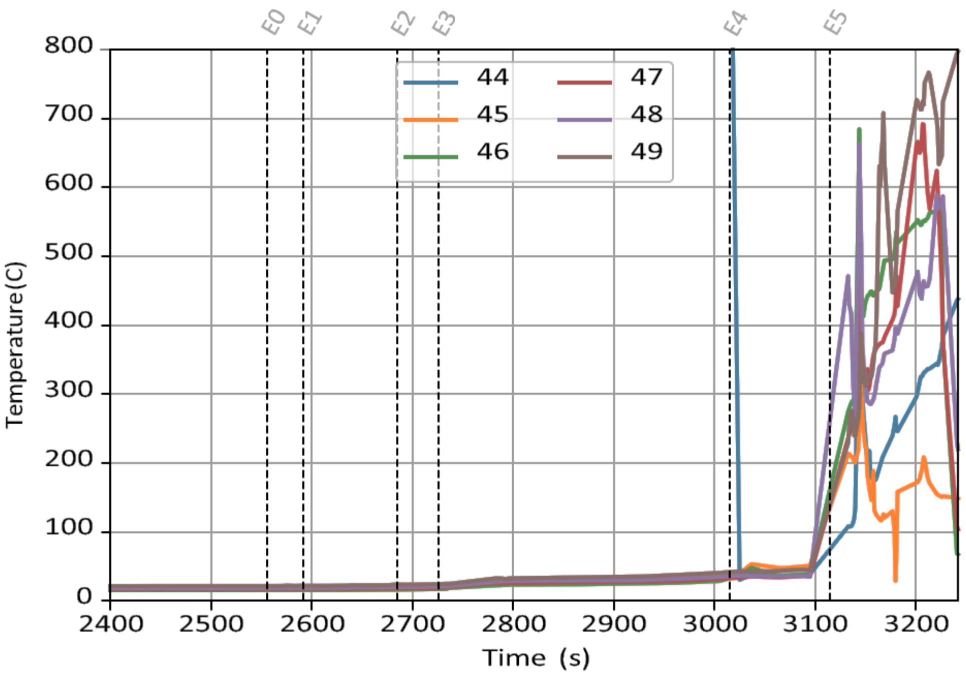


Figure 26 Temperature measurements of right target unit.

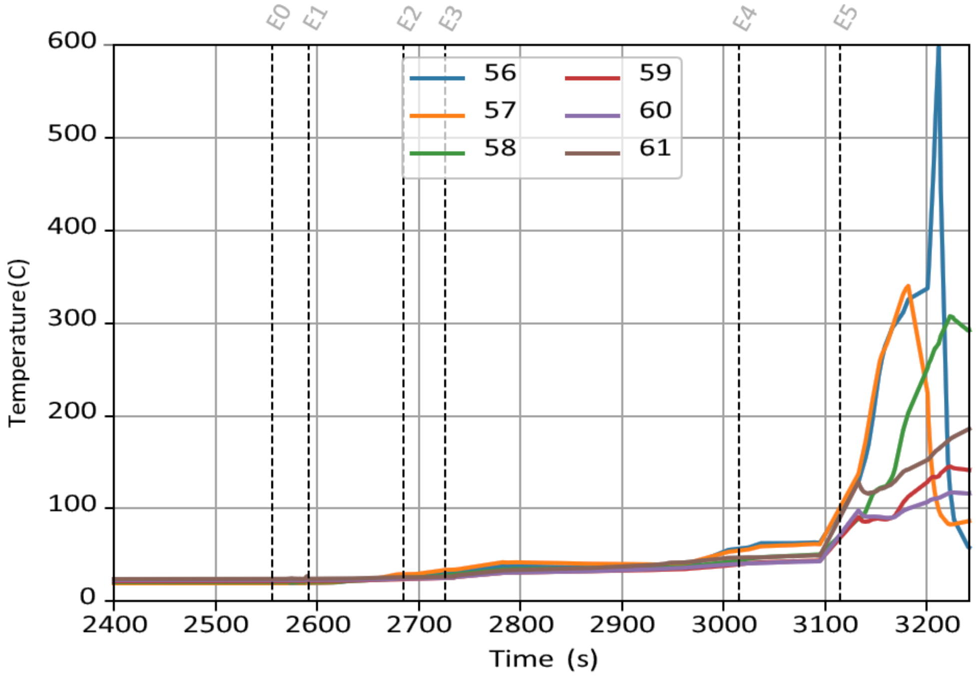


Figure 27 Temperature measurements of rear target unit

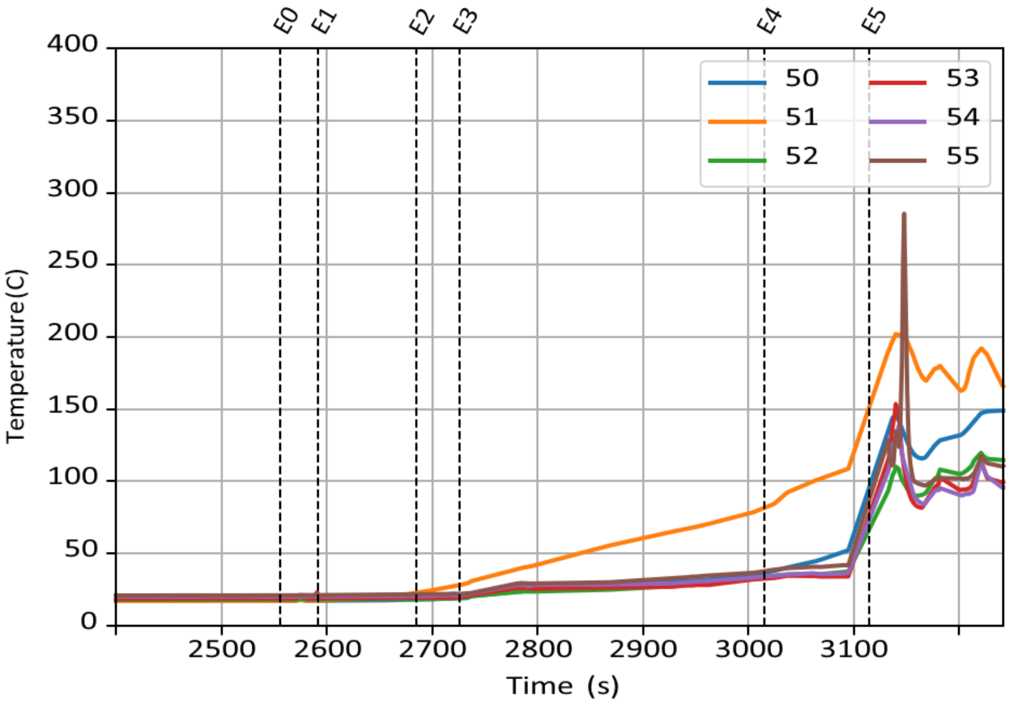


Figure 28 Temperature measurements of left target unit

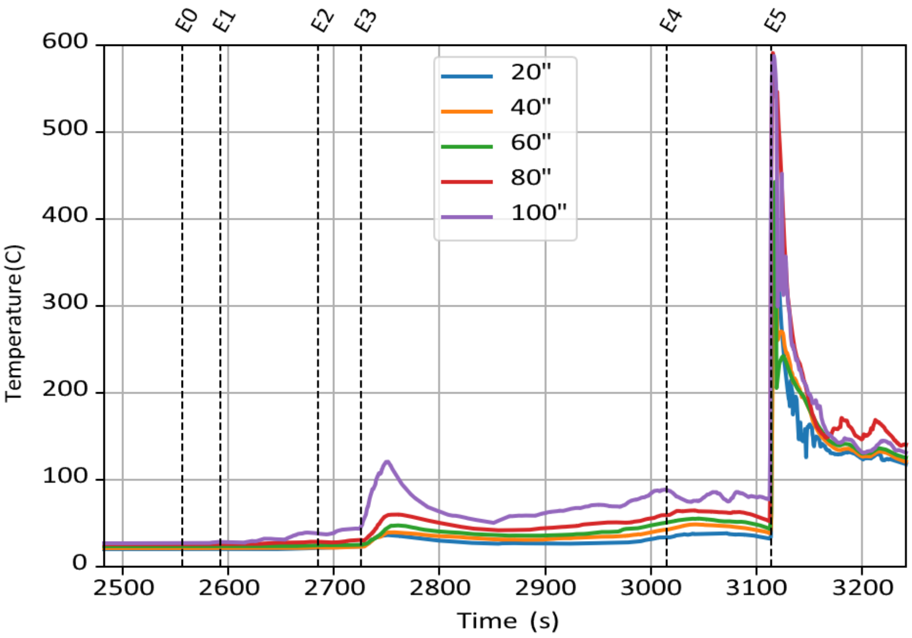
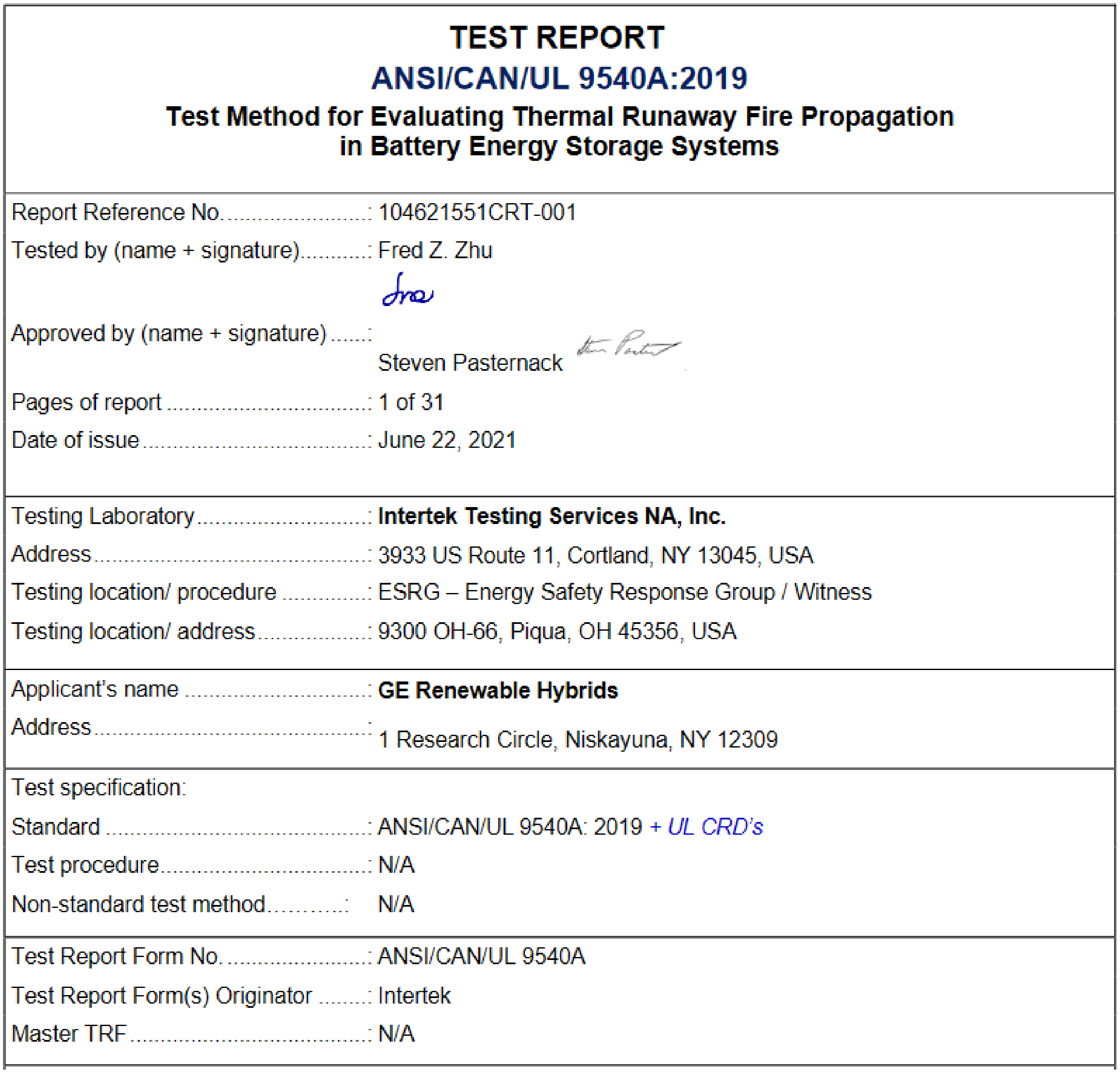


Figure 29 Temperature measurements of enclosure gas temperature; presented as distance above the floor

2.2. Test results as reported by NRTL

Please note that sections of the standard with verdicts of “Not Applicable” may have been truncated in the Report.



TEST REPORT
ANSI/CAN/UL 9540A:2019
Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

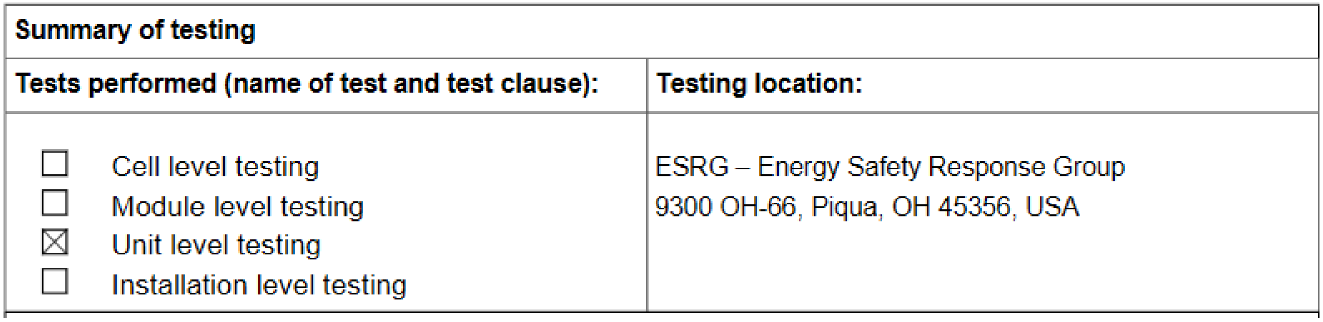
Report Reference No. ....: 104621551CRT-001
Tested by (name + signature)............: Fred Z. Zhu
Approved by (name + signature) ....: Steven Pasternack
Pages of report ....: 1 of 31
Date of issue ....: June 22, 2021

Testing Laboratory ....: **Intertek Testing Services NA, Inc.**
Address ....: 3933 US Route 11, Cortland, NY 13045, USA
Testing location/ procedure ....: ESRG – Energy Safety Response Group / Witness
Testing location/ address ....: 9300 OH-66, Piqua, OH 45356, USA

Applicant’s name ....: **GE Renewable Hybrids**
Address ....: 1 Research Circle, Niskayuna, NY 12309

Test specification:
Standard ....: ANSI/CAN/UL 9540A: 2019 *+ UL CRD’s*
Test procedure......................................: N/A
Non-standard test method………..: N/A

Test Report Form No. ....: ANSI/CAN/UL 9540A
Test Report Form(s) Originator ....: Intertek
Master TRF ....: N/A

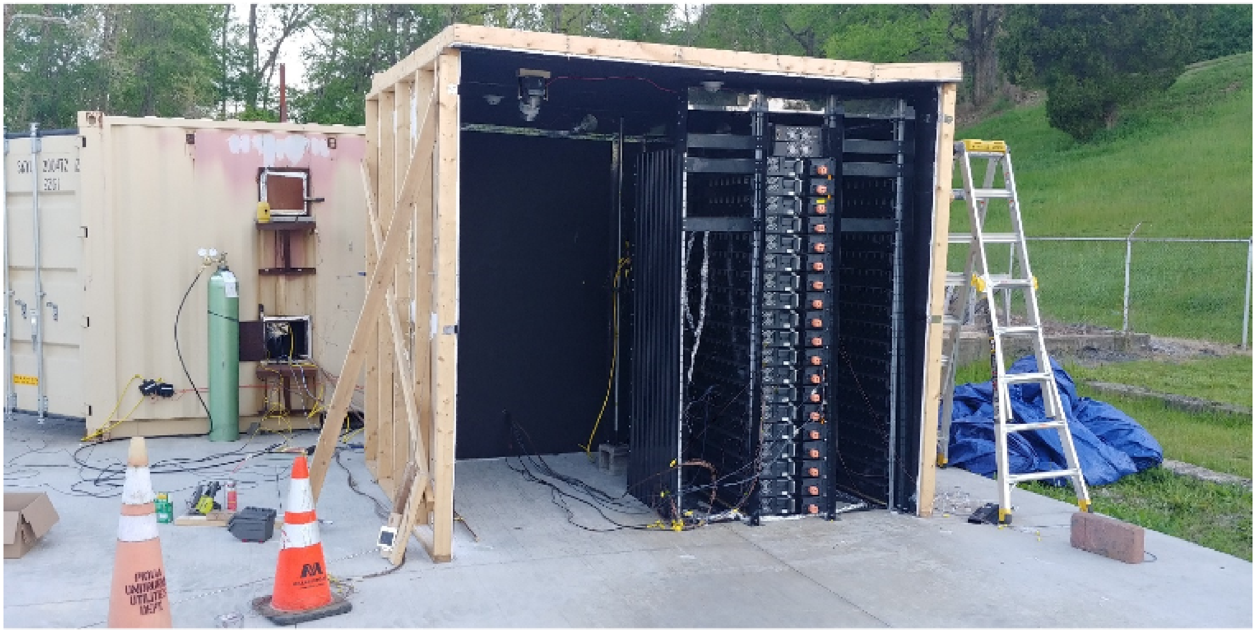


Summary of testing	
Tests performed (name of test and test clause):	**Testing location:**
☐ Cell level testing ☐ Module level testing ☒ Unit level testing ☐ Installation level testing	ESRG – Energy Safety Response Group 9300 OH-66, Piqua, OH 45356, USA

(MARKING PLATE REDACTED DUE TO BESS OEM PROPRIETARY RIGHTS)

Test item particular	**Battery Energy Storage System (ESS)**
Equipment mobility	☒ stationary ☐ mobile ☐ portable
Installation method	☒ floor ☐ wall-mount ☐ rooftop/open garage
Installation location	☐ residential ☒ non-residential
Environmental category	☒ outdoor ☐ indoor conditional ☐ indoor unconditional
Connection to the mains	☒ permanent connection ☐ direct plug-in ☐ pluggable equipment ☐ for building-in
Class of equipment	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg or lb)	87,110 lb*
Dimension of equipment (cm or inch)	20' (L) x 8' (W) x 9.6' (H)*
Pollution degree	☐ PD1 ☐ PD2 ☒ PD3
IP protection class or NEMA rating	NEMA Type 4

*Remarks: the tested sample is a simulated container – half sized with only one fully loaded rack and Stat-X fire suppression system 500E (4 installed), see photo below (per clause 9.1.3 of ANSI/CAN/UL 9540: 2019, as a representative of the GE BESS model RSU-4000).



Possible test case verdicts:

- test case does not apply to the test object	N/A
- test object is not evaluated for the requirement	N/E
- test object reaches the specified condition(s) / info	Yes or No
- test object setup completed as specified	Completed (C)
- test object does meet the requirement	Pass (P)
- test object does not meet the requirement	Fail (F)

Testing:

Date of receipt of test items ....: N/A

Date(s) of performance of tests ....: May 14, 2021

General remarks:

"(see Attachment #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

The tests results presented in this report relate only to the object tested.

This report shall not be reproduced except in full without the written approval of the testing laboratory.

List of test equipment must be kept on file and available for review.

Additional test data and/or information provided in the attachments to this report.

Throughout this report a ☐ comma / ☒ **point** is used as the decimal separator.

Determination of the test results includes consideration of measurement uncertainty from the test equipment and methods.

ANSI/CAN/UL 9540A			
Clause	Requirement – Test	Result – Remark	Verdict
5	**Construction – General**		
5.1	**Cell**		
5.1.1	The cells info associated with the BESS, including:		Yes
	- including cell chemistry (e.g. NMC, LFP);	LG li-ion chemistry (NMC)	P
	- the physical format of the cell;	Pouch	P
	- the cell electrical rating in capacity and nominal voltage;	72.5 Ah, 3.67 V	P
	- the overall dimensions of the cell, and weight.	100mm x 353mm x 16mm, 1170g	P
5.1.2	The cells associated with the BESS comply with ANSI/CAN/UL 1973 or not.	The JH4 cells are certified to UL 1642 (stated in cell level testing report - 9540A_LG_JH4 Cell Final Report 3-21-19)	N/A
5.1.3	Further details included in the cell level test report.	(Refer to cell level testing report - 9540A_LG_JH4 Cell Final Report3-21-19)	N/E
5.2	**Module**		
5.2.1	The modules info associated with the BESS, include:		Yes
	- the generic enclosure material;	Metal enclosure	P
	- the general layout of the module contents;	Consists of 56 JH4 cells with built-in thermal management	P
	- the electrical configuration of the cells in the modules and the modules in the BESS.	Module rated 51.8 V and 290 Ah	P
5.2.2	The modules associated with the BESS comply with UL 1973 or not.	No cert info for the tested module (Model EM048218P5B9)	N/E
5.2.3	Further details included in the module level test report.	(refer to module EM048290P5B1 testing report – 9540A LG Chem JH4 module report_12-12-18_final)	N/E
5.3	**Battery energy storage system unit**		
5.3.1	The BESS unit info, include:		
	- the units comply with UL 9540 or not;	The GE BESS RSU with UL 9540 Limited Production Certificate	N/E

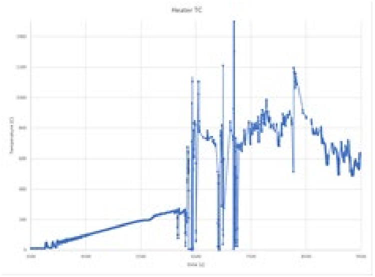
	• the manufacturer and model number;	(see page 2)	P
	• electrical ratings;	(see page 2 for the whole system)	P
	• energy capacity of all BESS.	(see page 2 for the whole system)	P
5.3.2	For BESS units, which UL 9540 compliance cannot be determined, to include:		
	• the number of modules in the BESS;	19 modules in one rack (tested)	P
	• electrical configuration of the module;	Module rated 51.8V, 290Ah	P
	• physical layout of the modules in the BESS;	(see photo in page 3)	P
	• battery management system (BMS); and	No info provided	N/E
	• other major components of the BESS;	No info provided	N/E
	• the BESS enclosure overall dimensions and generic material;	(see page 2)	P
	• battery system(s) may be tested as representative of the BESS;	A fully loaded BESS rack (19) modules with (2) BPU converters	P
	• battery system complies with UL 1973 or not.	No updated certificate info	N/E
5.3.3	Any fire detection and suppression systems that are an integral part of the BESS.	Stat-X fire suppression system 500E installed and testedtogether	Yes
5.3.4	Further details included in the unit level and if applicable, installation level test reports.	(refer to 9.7, 10.4 and 10.7)	Yes
5.4	**Flow Batteries**		**N/A**
6	**Performance – General**		
6.1	The tests in this standard are extreme abuse conditions conducted on electrochemical energy storage devices, which may result in various kind of hazards.	Safety measures ensured during the testing day	P
6.2	At the conclusion of testing, samples discharged in accordance with the manufacturer' specifications.	Sample handled by local authorities after the testing	P
	All samples disposed of in accordance with local regulations.	Sample disposed by local authorities after the testing	P
7	**Cell Level**		
7.1	**General**		**N/A**
7.2	**Sample**		**N/A**
7.3	**Determination of thermal runaway methodology**		**N/A**

7.4	**Cell vent gas composition test**		**N/A**
7.5	**Off gas composition for flow battery systems**		**N/A**
7.6	**Cell level test report**		**N/A**
7.7	**Performance – cell level test**		**N/A**
7.8	**Performance – flow battery thermal runaway determination tests**		**N/A**
8	**Module Level**		
8.1	**Sample**		**N/A**
8.2	**Test method**		**N/A**
8.3	**Module level test report**		**N/A**
8.4	**Performance at module level testing**		**N/A**
9	**Unit Level**		
9.1	**Sample and test configuration**		
9.1.1	The unit level test shall be conducted with BESS units installed as described in the manufacturer's instructions and this section.	Tested for "Outdoor ground mounted non-residential use BESS"	Yes
9.1.2	The unit level test requires one initiating BESS unit and target adjacent BESS units representative of an installation.	An internal fire condition as in the module level test is initiated	C
	Tests conducted for indoor floor mounted *installations for residential BESS may be* considered representative of both indoor floor mounted and outdoor ground mounted installations.	*(modified by UL CRD-2020.10.21)*	N/A
	Exception: Testing can be conducted outdoors for outdoor only installations with controlled environment.	Unit was tested for outdoor installation	C
9.1.3	Depending upon the configuration and design of the BESS (e.g. the BESS is composed of multiple separate parts within separate enclosures), this testing to determine fire characterization can be done at the battery system level.	A fully loaded BESS rack tested within the simulated container with 4 Stat-X 500E installed, which is agreed between the applicant and the testing labs	C
9.1.4	The initiating BESS unit shall contain components representative of a BESS unit in a complete installation. Combustible components that interconnect the initiating and target BESS units shall be included.	The initiating module installed at the lower part (#7 from the bottom) of the tested BESS rack (See the photo of page 3 too)	C
9.1.5	Target BESS units shall include the outer cabinet, racking, module enclosures, and components that retain cells components. The target BESS unit module enclosures do not need to contain cells.	Three target BESS racks installed near the initiating BESS rack, butno modules in the target racks (agreed with the relevant parties)	C

9.1.6	The initiating BESS unit shall be at the maximum operating state of charge (MOSOC) for conducting the tests in this standard. After charging and prior to testing, the initiating BESS shall rest for a maximum period of 8h at room ambient.	All 19 modules within the initiating BESS, charging conditions were measured before the testing	C
9.1.7	If a BESS unit includes an integral fire suppression system, there is an option of providing this with the DUT. If the BESS unit is provided with an optionalintegral fire suppression system, the system shall notbe provided on the DUT.	Stat-X fire suppression system (model 500E, 4pcs.) installed as integral part and tested together	C
9.1.8	Electronics and software controls such as the battery management system (BMS) in the BESS are not relied upon for this testing.	Unit protection means were disabled during the testing	N/A
	This does not include a fire suppression control that is external to the BESS, but provided as part of an integral fire suppression system per 9.1.7	The Stat-X fire 500E was considered as integral parts of inside the BESS	N/A
9.2	**Test method – Indoor floor mounted BESS units**	(referred by clause 9.3 as well)	
9.2.1	During the test, the test room environment shall be controlled to prevent drafts that may affect test results.	(Ambient is 19.1°C at the testing start with humidity of 30.1% RH)	P
9.2.2	Any access door(s) or panels on the initiating BESS unit and adjacent target BESS units shall be closed, latched and locked.	Closed enclosure tested to simulate the BESS conditions	C
9.2.3	The initiating BESS unit shall be positioned adjacent to two instrumented wall sections.	(See photo in page 3)	C
9.2.4	Instrumented wall sections shall extend not less than 0.49m horizontally beyond the exterior of the target BESS units.	Simulating the actual installation within the container	C
9.2.5	Instrumented wall sections shall be at least 0.61m taller than the BESS unit height, but not less than 3.66m in height above the bottom surface of the unit.	Simulating the actual installation within the container	C
9.2.6	The surface of the instrumented wall sections shall be covered with 16-mm (5/8-in) gypsum wallboard and painted flat black.	The simulated testing enclosure is consisting of 5/8” gypsum wall board and painted flat black	C
9.2.7	The initiating BESS unit shall be centered underneath an appropriately sized smoke collection hood of an oxygen consumption calorimeter.	Excluded by clause 9.3.1 for outdoor use only installation	N/A
9.2.8	The light transmission in the calorimeter’s exhaust duct shall be measured for the duration of the test, and the smoke release rate shall be calculated.	Excluded by clause 9.3.1 for outdoor use only installation	N/A
9.2.9	The chemical and convective heat release rates shall be measured for the duration of the test, respectively.	Excluded by clause 9.3.1 for outdoor use only installation	N/A
9.2.10	The heat release rate measurement system shall be calibrated using flows of 3.8, 7.6, 11.4 and 15.2 L/min (1, 2, 3 and 4 gpm) of heptane.	Excluded by clause 9.3.1 for outdoor use only installation	N/A

9.2.11	The convective heat release rate shall be measured using a thermopile, a velocity probe, and a Type K thermocouple, located in the exhaust system of the exhaust duct.	Excluded by clause 9.3.1 for outdoor use only installation	N/A
9.2.12	The convective heat release rate shall be calculated using the following equation: $HRR_c = V_e A \frac{353.22}{T_e} \int_{T_o}^{T} C_p dT$	Excluded by clause 9.3.1 for outdoor use only installations	N/A
9.2.13	The physical spacing between BESS units (both initiating and target) and adjacent walls shall be representative of the intended installation.	As specified in intended installation (side to side no gap, back-to-back with 8" distance)	C
9.2.14	Separation distances shall be specified by the manufacturer for distance between:		C
	a) The BESS units and the instrumented wall sections; and	Side ¾" and front 5-1/2" from the instrumented walls	C
	b) Adjacent BESS units.	No spacing between side BESS racks, 8" away from back BESS target rack (as specified by GE)	C
9.2.15	Wall surface temperature measurements shall be collected for BESS intended for installation in locations with combustible construction.	(see figure 11 of reference 1)	C
	If the intended installation is composed completely of noncombustible construction in which wall assemblies, cables, wiring and any other combustible materials are not to be present in the BESS installation, then the report should note that the installation shall contain no combustible construction and that surface temperature rises can be deemed not applicable.	Not intended for noncombustible installation surface only	N/A
9.2.16	Wall surface temperatures shall be measured in vertical array(s) at 152-mm (6-in) intervals for the full height of the instrumented wall sections.	#24-gauge, Type-K exposed junction thermocouples used	C
	The thermocouples for measuring the temperature on wall surfaces shall be horizontally positioned in the wall locations anticipated to receive the greatest thermal exposure from the initiating BESS unit.	The thermocouples were positioned as required, see figure 11 of reference 1 too	C
9.2.17	Thermocouples shall be secured to gypsum surfaces by the use of staples placed over the insulated portion of the wires.	The thermocouples were fixed as required	C
	The thermocouple tip shall be depressed into the gypsum so as to be flush with the gypsum surface at the point of measurement and held in thermal contact with the surface at that point by the use of pressure-sensitive paper tape.	The thermocouples were depressed into the instrumented wall as required	C
9.2.18	Heat flux shall be measured with the sensing element of at least two water-cooled Schmidt- Boelter gauges at the surface of each instrumented wall:		C

	a) Both are collinear with the vertical thermocouple array;		C
	b) One is positioned at the elevation estimated to receive the greatest heat flux due to the thermal runaway of the initiating module; and	(see figure 11 of reference 1)	C
	c) One is positioned at the elevation estimated to receive the greatest heat flux during potential propagation of thermal runaway within the initiating BESS unit.	(see figure 11 of reference 1)	C
9.2.19	Heat flux shall be measured with the sensing element of at least two water-cooled Schmidt-Boelter gauges at the surface of each adjacent target BESS unit that faces the initiating BESS unit:		C
	a) One is positioned at the elevation estimated to receive the greatest heat flux due to the thermal runaway of the initiating module within the initiating BESS; and	(see figure 11 of reference 1)	C
	b) One is positioned at the elevation estimated to receive the greatest surface heat flux due to the thermal runaway of the initiating BESS.	(see figure 11 of reference 1)	C
9.2.20	For non-residential use BESS, heat flux be measured with the sensing element of at least one water-cooled Schmidt-Boelter gauge positioned at the mid height of the initiating unit in the center of the accessible means of egress.	(see figure 11 of reference 1)	C
9.2.21	Measure the temperature of:	(#24-gauge, type-K exposed TC)	C
	• the surface proximate to the cells and between the cells and exposed face of the initiating module;	(see figure 11 of reference 1)	C
	• Each non-initiating module enclosure within the initiating BESS unit;	(see figure 11 of reference 1)	C
	• convoluted enclosure interior geometries.	(see figure 11 of reference 1)	C
9.2.22	For residential use BESS, the DUT shall be covered with a single layer of cheese cloth ignition indicator.	Not residential use BESS	N/A
9.2.23	An internal fire condition in accordance with the module level test shall be created within a single module in the initiating BESS unit:		C
	a) The position of the module shall be selected to present the greatest thermal exposure to adjacent modules, based on the results from the module level test; and	Initiating module located at the bottom area (#7)	C

	b) The setup (i.e. type, quantity and positioning) of equipment for initiating thermal runaway in the module shall be the same as that used to initiate and propagate thermal runaway within the module level test (Section 8).	Same thermal runaway method used as that of module testing. The heater's temperature vs. time curve: 	C
9.2.24	The composition, velocity and temperature of the initiating BESS unit vent gases shall be measured within the calorimeter's exhaust duct as in 8.2.10.	Excluded by clause 9.3.1 for outdoor use only installations	N/A
	The hydrocarbon content of the vent gas shall be measured using flame ionization detection.		N/A
	Hydrogen gas shall be measured with a palladium-nickel thin-film solid state sensor		N/A
9.2.25	*The hydrocarbon components of the vent gas composition may additionally be* measured using a Fourier-Transform Infrared Spectrometer with a minimum resolution of 1 cm^{-1} and a path length of at least 2 m, or an equivalent gas analyzer.	*(modified by UL CRD-20200110)*	N/A
9.2.26	The test shall be terminated if:		
	a) Temperatures measured inside each module within the initiating BESS unit return to ambient temperature;		N/A
	b) The fire propagates to adjacent units or to adjacent walls; or		N/A
	c) A condition hazardous to test staff or the test facility requires mitigation.	Testing terminated @11:14:13 of 05-14-2021 (3015 seconds after testing started) when a potential of explosion observed within the testing enclosure due to the high concentration of vented gases	Yes
9.2.27	For residential use systems, the gas collection data shall be compared to the smallest room installation specified by the manufacturer to determine if the flammable gas collected exceeds 25% LFL in air.	Not a residential use BESS (see table 9.1)	N/A
9.3	**Test method – Outdoor ground mounted units**		
9.3.1	Outdoor ground mounted non-residential use BESS being evaluated for installation in close proximity to buildings and structures.	(see relevant info in clause 9.2)	C

	If intended for outdoor use only installations, the smoke release rate, the convective and chemical heat release rate and content, velocity and temperature of the released vent gases need not be measured.	Tested for outdoor installations	C
9.3.2	Outdoor ground mounted residential use BESS being evaluated for installation in close proximity to buildings and structures.	(the test method described in section 9.2)	C
	Heat flux measurements for the accessible means of egress.	(measured in accordance with 9.2.20)	C
	If intended for outdoor use only installations, the smoke release rate, the convective and chemical heat release rate and content, velocity and temperature of the released vent gases need not be measured.	Outdoor used installations tested	C
9.3.3	Test samples shall be installed as shown in Figure 9.2 in proximity to an instrumented wall section.	(see photo in page 3)	C
	The sample shall be mounted on a support substrate and spaced from the wall in accordance with the minimum separation distances specified by the manufacturer.		C
	Exception: If the manufacturer requires installation against non-flammable material, the test setup may include manufacturer recommended backing material between the unit and plywood wall.	Not specified by manufacturer	N/A
9.3.4	Target BESS shall be installed on each side of the initiating BESS and keep the min. separation distances specified by the manufacturer.	Two racks side and one rack back to the initiating rack	C
9.4	**Test Method – Indoor wall mounted units**		**N/A**
9.5	**Test Method – Outdoor wall mounted units**		**N/A**
9.6	**Rooftop and open garage installations**		**N/A**
9.7	**Unit level test report**		**--**
9.7.1	The report on the unit level testing shall identify the type of installation being tested, asfollows:		Yes
	a) Indoor floor mounted non-residential use BESS;		N/A
	b) Indoor floor mounted residential use BESS;		N/A
	c) Outdoor ground mounted non-residential use BESS;	Tested in this application	Yes
	d) Outdoor ground mounted residential use BESS;		N/A
	e) Indoor wall mounted non-residential use BESS;		N/A
	f) Indoor wall mounted residential use BESS;		N/A

	g) Outdoor wall mounted non-residential use BESS;		N/A
	h) Outdoor wall mounted residential use BESS;		N/A
	i) Rooftop installed non-residential use BESS; or		N/A
	j) Open garage installed non-residential use BESS.		N/A
9.7.2	If testing is intended to represent more than one installation type, this shall be noted in the report.	Tested in outdoor mounted non-residential use BESS	N/A
9.7.3	The report shall include the following, as applicable:		--
	a) Unit manufacturer name and model number (and whether UL 9540 compliant);	The GE RSU with Limited Production Certificate per UL 9540, the tested sample is a simulation to the GE model RSU-4000. (see page 3 description of this report too)	N/E
	b) Number of modules in the initiating BESS unit;	19 modules within the tested rack	Yes
	c) The construction of the initiating BESS unit per 5.3;	(see clause 5.3 for details)	Yes
	d) Fire protection features/detection/suppression systems within unit;	Tested together with Stat-X fire suppression system 500E	Yes
	e) Module voltage(s) corresponding to the tested SOC;	Measured 58.85Vdc to 58.90Vdc for the modules after fully charged	Yes
	f) The thermal runaway initiation method used;	Heating cell by film heaters	Yes
	g) Location of the initiating module within the BESS unit;	#7 module initiated (counted from the bottom), total of 19 modules in one rack	Yes
	h) Diagram and dimensions of the test setup including mounting location of the initiating and target BESS units, and the locations of walls, ceilings, and soffits;	(see reference 1)	Yes
	i) Observation of any flaming outside the initiating BESS enclosure and the maximum flame extension;	No observation of any flaming before the testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	j) Chemical and convective heat release rate versus time data;	Excluded by clause 9.3.1 for outdoor use only installation	N/A
	k) Separation distances from the initiating BESS unit to target walls (A and C in Figure 9.1);		Yes
	l) Separation distances from the initiating BESS unit to target BESS units (D and H in Figure 9.1);		Yes

	m) The maximum wall surface and target BESS temperatures achieved during the test and the location of the measuring thermocouple;	(*see table 9.1)	N/E*
	n) The maximum ceiling or soffit surface temperatures achieved during the indoor or outdoor wall mounted test and the location of the measuring thermocouple;	Not wall mounted BESS	N/A
	o) The maximum incident heat flux on target wall surfaces and target BESS units;	(*see table 9.1)	N/E*
	p) The maximum incident heat flux on target ceiling or soffit surfaces achieved during the indoor or outdoor wall mounted test;	Not wall mounted unit	N/A
	q) Gas generation and composition data	(*see table 9.1)	Yes*
	r) Peak smoke release rate and total smoke release data;	Excluded by clause 9.3.1 for outdoor use only installation	N/A
	s) Indication of the activation of integral fire protection systems and if activated the time into the test at which activation occurred;	At the moment of 2726 seconds from testing started, the integral Stat-X 500E discharged	Yes
	t) Observation of flying debris or explosive discharge of gases;	No observation of flying debris before the testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	u) Observation of re-ignition(s) from thermal runaway events;	No observation of re-ignitions before the testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	v) Observation(s) of sparks, electrical arcs, or other electrical events;	None observed before the testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	w) Observations of the damage to:		N/E*
	1) The initiating BESS unit;	Testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	2) Target BESS units;	Testing terminated @11:14:13 of 05-14-2021 (*see table 9.1 for details)	N/E*
	3) Adjacent walls, ceilings, or soffits; and	Testing terminated @11:14:13 of 05-14-2021	N/E*

		(*see table 9.1 for details)	
	x) Photos and video of the test.	(Recorded)	Yes
9.8	**Performance at unit level testing**		--
9.8.1	Installation level testing in Section 10 is not required if the performance conditions outlined in Table 9.1 are met during the unit level test.	Performance conditions outlinedin table 9.1 is undetermined (*see table 9.1 of this report)	N/E*
10	**Installation Level**		
10.1	**General**		**N/A**
10.2	**Sample**		**N/A**
10.3	**Test method 1 – Effectiveness of sprinklers**		**N/A**
10.4	**Installation level test report – Test method 1 – Effectiveness of sprinklers**		**N/A**
10.5	**Performance – Test method 1 – Effectiveness of sprinklers** (also for Test method 2)		**N/A**
10.6	**Test method 2 – Effectiveness of fire protection plan**		**N/A**
10.7	**Installation level test report – Test method 2 – Effectiveness of fire protection plan**		**N/A**
10.8	**Performance – Test method 2 – Effectiveness of fire protection plan**		**N/A**

Table 9.1	**Unit Level Performance Criteria**	**N/E***
1. Non-Residential Installations		
(1) Indoor Floor Mounted	a) Flaming outside the initiating BESS unit is not observed;	--
	b) Surface temperatures of modules within the target BESS units adjacent to theinitiating BESS unit do not exceed the temperature at which thermally initiatedcell venting occurs, as determined in 7.3.1.8;	--
	c) For BESS units intended for installation in locations with combustible constructions, surface temperature measurements on wall surfaces do not exceed 97°C of temperature rise above ambient per 9.2.15;	--

	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	--
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	--
(2) Outdoor Ground Mounted	a) If flaming outside of the unit is observed, separation distances to exposures shall be determined by greatest flame extension observed during test.	*N/E (see NOTES)
	Remarks: no flaming observed before testing stopped @11:14:13 of 05-14-2021	--
	b) Surface temperatures of modules within the target BESS units adjacent to theinitiating BESS unit do not exceed the temperature at which thermally initiatedcell venting occurs, as determined in 7.3.1.8;	* N/E (see NOTES)
	Remarks: the target racks' surface temperatures are not exceeded the temperature at which thermally initiated cell vented occurs before testing stopped @11:14:13 of 05-14-2021, see below temperature data (max. from 0 to 3015s): Right BESS rack (TC# 48): 42.4°C Left BESS rack (TC# 54): 36.8°C Rear BESS rack (TC# 55): 57.8°C Initiating BESS cell (venting, TC# 69): 373.1°C	--
	c) For BESS units intended for installation near exposures, surface temperature measurements on wall surfaces do not exceed 97°C of temperature rise aboveambient per 9.2.15;	N/E* (see NOTES)
	Remarks: (1) the max. temperature rise data before the testing stopped @11:14:13 of 05-14- 2021 is exceeded 97°C above the ambient (19.1°C) at ceiling and front wall, details: Right Wall (TC# 14): 64.3°C (ΔT = 45.2°C < 97°C) Ceiling (TC# 18): 130.9°C (ΔT = 111.8°C > 97°C) Front Wall (TC# 37): 169.1°C (ΔT = 150.0°C > 97°C) (2) if the final installation is not near exposures, as specified in note 1) of table 9.1,this requirement can be excluded.	--
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	N/E* (see NOTES)
	Remarks: (1) Potential explosion hazards observed (see below NOTES for detailed gas info)and the testing terminated @11:14:13 of 05-14-2021. (2) The result for this item is undetermined, as the test configuration changed (the roof was opened at 11:14:13 of 05-14-2021, thus the testing was not continued asdesigned per reference 1).	--

	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	N/E* (see NOTES)
	Remarks: (1) the max. heat flux (in kW/m^2) before the testing stopped @11:14:13 of 05-14-2021 is listed here:	--

HFG #	Location	Max. measured heat flux (kW/m^2)
01	Left Target (High)	≥100*
02	Left Target (Low)	45.6
03	Right Target (High)	24.9
04	Right Target (Low)	34.7
05	Back Target (High)	≥100*
06	Back Target (Low)	≥50*
07	Right Wall (High)	≥20*
08	Right Wall (Low)	≥20*
09	Front Wall (High)	≥50*
10	Front Wall (Low)	≥50*
11	Ceiling (Front)	134.6
12	Ceiling (Right)	≥200*

*The measured data over the measurement range of the heat flux gauge.

(2) if the final installation is made without accessible means of egress as specifiedin note 2) of table 9.1, this requirement can be excluded.

NOTES:

- *Testing terminated @11:14:13 of May 14, 2021 (3015 seconds after the testing started) by opened the testing enclosure roof near the tested battery rack when a potential of explosion observed within the testing enclosure with high concentration of vented gases (see below data at the moment). This is for the safety of testing facilities and the people per clause 9.2.26 condition c) of UL 9540A: 2019, thus the data collected inthis report is only representing the results within the testing duration of 3015 seconds and is for reference only, it is not the final results of the performance of the EUT (unit under testing).*

Gas	Maximum Concentration
Carbon Dioxide	≥54543 ppm
Carbon Monoxide	≥ 3091 ppm
Hydrogen	29235 ppm
Unburned Hydrocarbons	≥31751 ppm

(3) Indoor Wall Mounted	a) Flaming outside the initiating BESS unit is not observed;	--
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiatedcell venting occurs, as determined in 7.3.1.8;	--

	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C of temperature rise above ambient per 9.2.15;	--
	d) Explosion hazards are not observed, including deflagration, detonation, or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	--
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	--
(4) Outdoor Wall Mounted	a) Flaming outside the initiating BESS unit is not observed;	--
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiatedcell venting occurs, as determined in 7.3.1.8;	--
	c) For BESS units intended for installation on walls with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C of temperature rise above ambient per 9.2.15;	--
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	--
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	--
(5) Rooftop and Open Garages	a) If flaming outside the unit is observed, separation distances to exposures shallbe determined by greatest flame extension observed during test;	--
	b) Surface temperatures of modules within the target BESS units adjacent to the initiating BESS unit do not exceed the temperature at which thermally initiatedcell venting occurs, as determined in 7.3.1.8;	--
	c) For BESS units intended for installation in locations with combustible construction, surface temperature measurements on wall surfaces do not exceed 97°C of temperature rise above ambient per 9.2.15;	--
	d) Explosion hazards are not observed, including deflagration, detonation or accumulation (to within the flammability limits in an amount that can cause a deflagration) of battery vent gases; and	--
	e) Heat flux in the center of the accessible means of egress shall not exceed 1.3 kW/m^2.	--
2. Residential Installations		**Result**
		N/A

Annex 1: Testing Equipment List:

Item #	Equipment	S/N	Calibration Due Date
1	Fluke multimeter 119	45260379SV	07/27/2021
2	FRA temperature measurement scope - National Instruments NI-9214	1720AE4	10/09/2021
3	Enclosure pressure data collection -National Instruments NI-9207	1A056F9	10/07/2021
4	HFG measurement module – National Instruments NI-9205	1BD3AD2, 17E9D35	10/08/2021
5	Ambient temperature and humidity probe - Omega HX303AV	50768	10/08/2021
6	Enclosure pressure measurement – Setra 26410R5WB2DT1F	10144247	04/19/2022
	Enclosure pressure measurement - Setra 26411R5WD2DT1F	9232163	06/29/2021
	Enclosure pressure measurement – Setra 2641003WD2DT1F	10144248	04/19/2022
7	Heat flux gauge secondary calibrations. Reference calibrations provided – Hukseflux SBG01	12851 and 13194	09/29/2021
8	Gases used for calibration of FRA gas analysis system - Praxair NI ME2.5P-AS	700010212UD	Varied (see calibration documents)
	Gases used for calibration of FRA gas analysis system - Praxair NI CD4.5CO5P-AS	700010213UB	
	Gases used for calibration of FRA gas analysis system - Praxair NI 5.0UH-T	200402005105	
	Gases used for calibration of FRA gas analysis system - Praxair HY 4.5Z-K	700010211D1	

About PVEL

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Public Comment No. 139-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent,- ~~as appropriate:~~

(1) ~~NFPA 15~~

(2) ~~NFPA 750~~

-

(1) NFPA 12

(2) NFPA 15

(3) NFPA 750

(4) NFPA 770

(5) NFPA 2001

(6) NFPA 2010

Statement of Problem and Substantiation for Public Comment

Chapter 4 applies to all battery types. Carbon Dioxide, hybrid (water mist/inert gas), clean agent, aerosol suppression systems have proven to be effective with various battery types included in this chapter. Exclusion of the standards covering these types of systems from this chapter is inappropriate.

Related Item

- Standards removed during first draft

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 18-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 12

(2) NFPA 15

(3) NFPA 750

(4) NFPA 770

(5) NFPA 2001

(6) NFPA 2010

Add to annex note:

Of the other automatic fire control systems, only systems NFPA 15 and NFPA 750 systems have proven successful in fires with lithium-ion battery ESSs.

Statement of Problem and Substantiation for Public Comment

Committee statement in support of removal indicates "Other fire control and suppression have not been shown to effectively control lithium battery fires except NFPA 15 and NFPA 750 systems" but perhaps these other suppression methods work for other BESS chemistries and should not be excluded. Otherwise, the standard should be limited to lithium-ion installations.

An annex note can be added if certain techniques are not effective on certain chemistries.

Related Item

- FR-45

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Committee: ESS-AAA

Public Comment No. 182-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.~~2~~ 1 *

The optional automatic fire control and suppression systems shall comply with the following standards, or their equivalent, ~~as appropriate~~ unless modified in chapters 9 through 17 :

(1) NFPA 12

(2) NFPA 15

(3) NFPA 750

(4) NFPA 770

(5) NFPA 2001

(6) NFPA 2010

Statement of Problem and Substantiation for Public Comment

As chapter 4 is meant to cover all ESS technologies, some of these standards my be applicable to those technologies, if they are not it is appropriate to change the application in the chapter that it doesn't apply.

Related Item

- FR 45

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 205-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 15

(2) NFPA 750

(3) NFPA 2010

Statement of Problem and Substantiation for Public Comment

Condensed Aerosols are approved for Class A, B & C fires which covers the risks found in numerous battery type fires.
NFPA 2010 reference should be included.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 209-NFPA 855-2024 [Section No. G.6.1.6 [Excluding any Sub-Sections]]	

Related Item

- FR-45-NFPA 855-2023

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Committee: ESS-AAA

Public Comment No. 277-NFPA 855-2024 [Section No. 4.9.3.2]

4.9.3.2*

The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:

(1) NFPA 15

(2) NFPA 750

(3) NFPA 2001

Statement of Problem and Substantiation for Public Comment

This standard covers more than lithium ion batteries. Additionally inerting agents are effective at suppressing lithium ion battery fires.

(Ofodike Ezekoye PhD,PE ‘s University of Texas at Austin November20, 2023 prensentation:

https://players.brightcove.net/1640544031001/default_default/index.html?videoId=6341563316112

KIT Report:

https://www.ffb.kit.edu/download/IMK%20Ber.%20Nr.%20192%20Kunkelmann%20Lithium-Ionen-%20und%20Lithium-Metall-Batterien%20Brandbekaempfung.pdf)

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 227-NFPA 855-2024 [Section No. G.6.1.5]	Submitter
Public Comment No. 250-NFPA 855-2024 [Section No. A.4.9.3.2]	Submitter

Related Item

- FR 45 4.9.3.2

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Committee: ESS-AAA

Public Comment No. 131-NFPA 855-2024 [Section No. 4.9.4]

4.9.4 Water Supply.

4.9.4.1*

Where required elsewhere in this standard, sites where nonmechanical ESSs are installed shall be provided with a permanent source of water for fire protection, unless modified in Chapters 9 through 13.

4.9.4.2

Where no permanent adequate and reliable water supply exists for firefighting purposes, the requirements of NFPA 1142 shall apply.

4.9.4.3

Accessible fire hydrants shall be provided for site ESS installations where a public or private water supply is available.

4.9.4.4

Fire hydrants installed on private fire service mains shall be installed in accordance with NFPA 24 or equivalent local requirement where NFPA 24 is not adopted.

4.9.4.5

Where provided, water storage tank shall be installed in accordance with NFPA 22.

Statement of Problem and Substantiation for Public Comment

adding appropriate NFPA standard for sizing of tank

Related Item

- Public Comment

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 134-NFPA 855-2024 [Section No. 4.10]

4.10 ~~Emergency~~ * Standby Power ~~Standby~~ Systems (SPS) .

Critical safety systems shall be provided with ~~reliable EPSS or SEPSS power.~~

~~4~~

standby power in accordance with NFPA 70 article 701 Legally Required Standby Systems.

A.4.10
At least two sources of power must be provided- one normal supply and one or more of the sources described in NFPA 70 article 701.12. Examples of types of combinations of sources by which to fulfill this requirement include, but are not limited to:

1) One normal service and a generator set (EPSS)

2) One normal service and a Stored-Energy Power Supply System (SEPSS)

Note NFPA 70 article 701.12 E (12) references the requirements of NFPA 855 for fire protection. SEPSS systems are considered BESS system and shall also meet the requirements of NFPA 855 current edition.

3)Separate Service- Where approved by the AHJ

4) Microgrid Systems

4 .10.1 *

Where EPSS or

~~SEPSS~~

SEPSS is provided they shall be Class X, Type 10, Level 2 as defined by NFPA 110 chapter 4 . 1.

4.10.1.1

EPSS shall comply with NFPA 110.

4.10.1.2

SEPSS shall comply with NFPA 111.

4.10.2 *

A registered design professional with a

~~fire protection~~

SPS design background shall evaluate evaluate the duration and total load requirements

~~for the EPSS and SEPSS~~

and define the specific loads to be served for the standby system. The design of the SPS shall be made available to the Fire RDP and the AHJ for review and approval .

4.10.3 *

EPSS or SEPSS Type 10 requirements shall be permitted to be reduced based on the HMA evaluation and a safe critical infrastructure load transfer.

4.10.4 SPS **shall be located separately and protected such that a failure event doesn’t compromise the operation of the system.**

Additional Proposed Changes

File Name	Description	Approved
Standby_power_markups_5-23-24_PC.docx	TG 27 all inclusive changes for Power	

Statement of Problem and Substantiation for Public Comment

The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. Additional definitions and a new Section 4.10 have been created to consolidate the power requirements and provide consistency. NFPA TG 27 has reviewed the PI 194 and provided additional clarification to requirements of NFPA 70, better definitions of response times, load requirements, engineering requirements and survivability input.

Related Item

• PI 194 • PI 190

Submitter Information Verification

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Committee:	ESS-AAA

All inclusive TG 27 Changes 5-23-24

FR 190 – No changes

3.3.10 Emergency Power Supply System (EPSS).

A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power. [**110,** 2022]

FR 117 – No changes

3.3.29 Registered Design Professional (RDP).

An individual who is registered or licensed to practice his/her respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed. [**5000,** 2024]

Existing Definition – No changes

3.3.35 Stored-Energy Emergency Power Supply System (SEPSS).

A system consisting of a UPS, a rectifier plant, or a motor generator powered by a stored electrical energy source; a transfer switch designed to monitor preferred and alternate load power source and provide desired switching of the load; and all necessary control equipment to make the system functional. [111, 2023?]

FR 194- PC

4.10* ~~Legally Required~~ Standby Systems~~Emergency Power Standby Systems~~.

Critical safety systems shall be provided with standby ~~reliable EPSS or SEPSS~~ power in accordance with NFPA 70 article 701 Legally Required Standby Systems.

A.4.10 At least two sources of power must be provided- one normal supply and one or more of the sources described in NFPA 70 article 701.12. Examples of types of combinations of sources by which to fulfill this requirement include, but are not limited to:

1) One normal service and a generator set (EPSS)

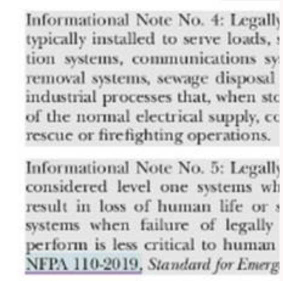
2) One normal service and a Stored-Energy Power Supply System (SEPSS)

Note NFPA 70 article 701.12 E (12) references the requirements of NFPA 855 for fire protection. SEPSS systems are considered BESS system and shall also meet the requirements of NFPA 855 current edition.

3)Separate Service- Where approved by the AHJ

4) Microgrid Systems

Commented [GC1]:



Informational Note No. 4: Legall
typically installed to serve loads,
tion systems, communications sy
removal systems, sewage disposal
industrial processes that, when sto
of the normal electrical supply, co
rescue or firefighting operations.

Informational Note No. 5: Legally
considered level one systems wh
result in loss of human life or
systems when failure of legally
perform is less critical to human
NFPA 110-2019, *Standard for Emerg*

Commented [CG2]: New language

Commented [RS3R2]: This is consistent with what was discussed within the subgroup

Commented [CG4]: EPSS

Commented [GC5]: Note SEPSS has a note 701.12 E (2) information note: See NFPA 855 2020 for additional information on fire protection installation requirements. Not sure if we need to have them update to 2023/2026 or make a note of it ourselves?

Commented [RS6R5]: concur

4.10.1*

Where EPSS or SEPSS is provides they shall be Class X, Type 10, Level 2.

A.4.10.1

The duration of the required EPSS of SEPSS as defined in Class X is time, in hours, as required by the application, code, or user. The ~~HMA~~ design of the EPSS system is used as part of the engineering analysis (along with, HMA, Fire Risk/Explosion Risk and electrical distribution system design) to determine a credible event and the duration of the event. Typically, for systems operating in standby mode, the duration should be a minimum of 24 hours for LIB ~~B~~ESSs. ~~Determining time requirements for an EPSS or SEPSS in alarm mode should be based on probable response times of the SME or first respondersS.~~ This ensures that the critical safety systems are functional to provide appropriate information to the SME or the first responders. Other references and codes might include the terms *secondary power*, *standby power*, or *auxiliary power*. For safety reliability, they are assumed to have the same requirements as an EPSS or SEPSS.

4.10.1.1

EPSS shall comply with NFPA 110.

4.10.1.2

SEPSS shall comply with NFPA 111.

4.10.2*

A registered design professional with a ~~fire protection~~EPSS design background shall evaluate the duration and total load requirements and define the specific loads to be served for the ~~EPSS and SEPSS~~standby system ~~including type, class, and level.~~ The design of the EPSS shall be made available to the FPE of Record and the AHJ for review and approval.

A.4.10.2

A typical evaluation would include all safety systems functioning in a failure event. Total load would be based on one ~~B~~ESS in failure with a safety margin ~~of one additional unit~~based on the HMA including the ~~HMA~~.supporting~~,~~ explosion, and loss of primary power analysis. ~~This evaluation should be supported by UL 9540A and propagation potential from the large-scale testing.~~ For units interconnected in a row, sizing of the EPSS should be based on row size.

4.10.3*

EPSS or SEPSS Type 10 requirements shall be permitted to be reduced based on the ~~HMA~~ supporting analyses that objectively demonstrates timeliness~~evaluation~~ and a safe critical infrastructure load transfer.

4.10.4 Standby power systems shall be located separately and protected such that a failure event doesn't compromise the operation of the system.

Rationale - PC –

The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. Additional definitions and a new Section 4.10 have been created to consolidate the power requirements and provide consistency. NFPA TG 27 has reviewed the PI 194 and provided

Commented [GC7]: We would need to adjust language as necessary for EPSS and SEPSS

Commented [GC8R7]: Article 701.12 says "legally required standby power will be available within the time required for the application but not to exceed 60 seconds." 4.10.3 would allow this

Commented [RS9R7]: Disagree. The HMA does not specify duration, the sub-analysis for the design of the EPSS does. EPSS response time has no bearing on how fast the first responders will get there. What are they going to do when they arrive? First responders have no responsibility to turn the SDG on or off upon arrival

Commented [PH10]: PC FR 194 - universal input to clean up BESS vs ESS

Commented [PH11]: Clarify SEPSS is a system provide for batteries, does it need to meet the requirements of BESS system? Bob comment that it is. Need Annex note to clarify? 111 Meant to remove gen sets and as such are now compliant to 855.

Commented [PH12R11]: Added clarification to annex that SEPSS are BESS

Commented [CG13]: Clarify FPE PE is not evaluating the electrical design but defining the requirements for the site via HMA.

Commented [GC14R13]: Further clarification why the design professional would need to define the type, class,and level if it was defined previously?

Commented [RS15R13]: FPE's do not typically have the design experience of EPSS... This is typically done by Electrical Engineering.

Commented [PH16R13]: Agree should not be FPE but should be RDP.

Commented [CG17]: Change to be based on HMA. It may determine more than one additional unit would be required. Example an entire string of interconnected units

Commented [RS18R17]: Disagree. The design of the EPSS integrates the analyses of the duration of the event that includes loss of power, fire, and explosion analyses. The HMA should integrate the results of this risk analyses and layer them with the suite of other engineering and administrative controls do demonstrate how this risk is mitigated.

additional clarification to requirements of NFPA 70, better definitions of response times, load requirements, engineering requirements and survivability input.

End New Chapter 4.10

Other References

2.4 References for Extracts in Mandatory Sections.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition.

NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2022 edition.

Annex A Explanatory Material

A.4.1

Chapter 4 requirements are intended to be applicable to all ESS technologies. However, it is recognized that hazards and mitigation requirements differ among the various ESS technologies covered by Chapters 9 through 15. This section allows requirements in those chapters to supplement or supersede the general requirements of Chapter 4.

ESS should comply with NFPA 111 where adopted and where intended for use as a stored-energy emergency power supply system (SEPSS).

Annex H Informational References

NFPA 110, Standard for Emergency and Standby Power Systems, 2022 edition.

NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2022 edition.

Reference Material and extractions - only provided for used in determined CI.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems, 2022 edition.*

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2022 edition.

110 -4.1 * General.

The EPSS shall provide a source of electrical power of required capacity, reliability, and quality to loads for a length of time as specified in Table 4.1(a) and within a specified time following loss or failure of the normal power supply as specified in Table 4.1(b).

Table 4.1(a) Classification of EPSSs

Class	Minimum Time
Class 0.083	0.083 hr (5 min)
Class 0.25	0.25 hr (15 min)
Class 2	2 hr
Class 6	6 hr
Class 48	48 hr
Class X	Other time, in hours, as required by the application, code, or user

Table 4.1(b) Types of EPSSs

Designation	Power Restoration
Type U	Basically uninterruptible (UPS systems)
Type 10	10 sec
Type 60	60 sec
Type 120	120 sec
Type M	Manual stationary or nonautomatic — no time limit

4.2 * Class. The class defines the minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged. *[See Table 4.1(a).]*

4.3 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. Table 4.1(b) provides the types defined by this standard.

4.4 * **Level.** This standard recognizes two levels for equipment installation, performance, and maintenance requirements.

4.4.1 * Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

4.4.2 * Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

4.4.3 * All equipment shall be permanently installed.

4.4.4 * Level 1 and Level 2 systems shall ensure that all loads served by the EPSS are supplied with alternate power that meets all the following criteria:

1. Of a quality within the operating limits of the load
2. For a duration specified for the class as defined in Table 4.1(a)
3. Within the time specified for the type as defined in Table 4.1(b)

3.3.5 Emergency Power Supply System (EPSS).
A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power. [**110,** 2019]

111-3.3.9 Power Supply.

3.3.9.1 * **Emergency Power Supply (EPS).** The source of electric power of the required capacity and quality for an emergency power supply system (EPSS). [**110,** 2019]

3.3.9.2 * **Uninterruptible Power Supply (UPS).** A device or system that provides quality and continuity of ac power through the use of a stored-energy device as the backup power source during any period when the normal power supply is incapable of performing acceptably.

Other Required Modification to the code due to Chapter 4.10

4.4.2.1*

The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:

1. A thermal runaway or mechanical failure condition in a single ESS unit
2. Failure of an energy storage management system or protection system that is not covered by the product listing failure modes and effects analysis (FMEA)
3. Failure of a required ~~protection~~ system including, but not limited to, ventilation (HVAC), ~~exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection~~cooling system, BMS, communication system, or other critical systems that might impact normal operations

4. **A.4.4.2.1**
5. Failures modes covered by 4.4.2 can include mechanical failure modes and are applicable to flywheel, stored pressure, and other types of ESSs other than electrochemical ESSs.

PIs [1]

4.4.2.2

Only single failure modes shall be considered for each mode given in 4.4.2.1.

FR-138Hide Legislative

4.4.2.3*

Consequences of single failures of a critical safety component or system, such as exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection or explosion control systems, during a thermal runaway or failure event shall be evaluated.

A.4.4.2.3

Failure of a critical safety component or system such as the fire alarm or explosion control system are not considered a dual fault condition. An example might be the loss of primary power or secondary power. This would be considered above and beyond the normal safety listing and evaluation. The protection features are required because the standard assumes an uncontrolled event occurred.

Public Comment No. 19-NFPA 855-2024 [Section No. 4.10]

~~**4.10** – Emergency Power Standby Systems.~~

~~Critical safety systems shall be provided with reliable EPSS or SEPSS power.~~

~~**4.10.1** * –~~

~~EPSS or SEPSS shall be Class X, Type 10, Level 2.~~

~~**4.10.1.1** –~~

~~EPSS shall comply with NFPA 110.~~

~~**4.10.1.2** –~~

~~SEPSS shall comply with NFPA 111.~~

~~**4.10.2** * –~~

~~A registered design professional with a fire protection background shall evaluate the duration and total load requirements for the EPSS and SEPSS.~~

~~**4.10.3** * –~~

~~EPSS or SEPSS Type 10 requirements shall be permitted to be reduced based on the HMA evaluation and a safe critical infrastructure load transfer.~~

Statement of Problem and Substantiation for Public Comment

This should be moved under the HMA section so its application is more limited, otherwise we will need emergency power for every standby UPS and lead-acid battery plant that uses mechanical ventilation for normal operation, which is already overkill based on the hazard. I am only aware of one hydrogen explosion from a domestic lead-acid standby power plant, and it was an abandoned building, with the HVAC turned off and batteries left on float for several months, not compliant with the current standard and in reality, an excellent demonstration of how much abuse the batteries need to become a hazard.

Related Item

• FR-104 •

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Public Comment No. 353-NFPA 855-2024 [Section No. 4.10]

4.10 Emergency Power Standby Systems.

Critical safety systems shall be provided with reliable EPSS or SEPSS power.

4.10.1*

EPSS or SEPSS shall be Class X, Type 10, Level 2.

4.10.1.1

EPSS shall comply with NFPA 110.

4.10.1.2

SEPSS shall comply with NFPA 111.

4.10.2*

A registered design professional with a fire protection background shall evaluate the duration and total load requirements for the EPSS and SEPSS.

4.10.3*

EPSS or SEPSS Type 10 requirements shall be permitted to be reduced based on the HMA evaluation and a safe critical infrastructure load transfer.

4.10.4*

Emergency power shall not be required on mechanical ventilation systems for lead-acid and nickel-cadmium batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(6) Utilized in uninterruptable power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located.

A 4.10.4 On loss of power to the charging system, lead-acid and nickel-cadmium batteries essentially cease generation of hydrogen gas. For this reason, interconnection of the mechanical ventilation power to the charging power negates the need for emergency power for the ventilation system.

Statement of Problem and Substantiation for Public Comment

For lead-acid and nickel-cadmium batteries, the generation of hydrogen is well understood and in normal operation occurs primarily during charging. Loss of charging power effectively stops hydrogen production and the need for associated mechanical ventilation. For this reason, additional power for ventilation, independent from power for rectification is not needed. These systems have high inherent safety without a need for emergency power for mechanical ventilation. Requiring emergency power for these systems adds complexity and cost with no additional safety benefit achieved.

Exemption list is consistent with recommendation by TG 24 on lead-acid and nickel-cadmium exemptions.

Related Item

- FR-194

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Committee:	ESS-AAA

Public Comment No. 84-NFPA 855-2024 [Section No. 4.10]

4.10 Emergency Power Standby Systems.

~~Critical~~ Where a loss of power would impair critical safety systems ~~shall~~ , these critical safety systems shall be provided with reliable EPSS or SEPSS power.

4.10.1*

EPSS or SEPSS shall be Class X, Type 10, Level 2.

4.10.1.1

EPSS shall comply with NFPA 110.

4.10.1.2

SEPSS shall comply with NFPA 111.

4.10.2*

A registered design professional with a fire protection background shall evaluate the duration and total load requirements for the EPSS and SEPSS.

4.10.3*

EPSS or SEPSS Type 10 requirements shall be permitted to be reduced based on the HMA evaluation and a safe critical infrastructure load transfer.

Statement of Problem and Substantiation for Public Comment

Not every critical safety system requires external power - some can be completely passive. In addition, many traditional standby power applications rely on ventilation fans that operate on commercial power, but when the commercial power fails, the charge current and result hydrogen generation also cease. So these safety systems are also not dependent on commercial power for safety - they are essentially "interlocked" so that on loss of power, the battery is put into a safe condition. Changing the charging statement to require emergency power only when justified by an HMA would improve safety where warranted, while not complicating otherwise very safe installations.

Related Item

- FR-104

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Committee: ESS-AAA

Public Comment No. 69-NFPA 855-2024 [New Section after 4.11]

Commentary on CI-22.

I think it is good that vehicle to grid applications need to follow NEC and manufacturer requirements. Are they exempt from all other parts of NFPA 855? If so, they seem under-regulated compared to all other stationary and mobile ESS. Perhaps more requirements are needed such as defining "temporary", the provision of fire rated partitions, fire detection and suppression.

Statement of Problem and Substantiation for Public Comment

I think it is good that vehicle to grid applications need to follow NEC and manufacturer requirements. Are they exempt from all other parts of NFPA 855? If so, they seem under-regulated compared to all other stationary and mobile ESS. Perhaps more requirements are needed such as defining "temporary", the provision of fire rated partitions, fire detection and suppression.

Related Item

- CI-22

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Committee:	ESS-AAA

Public Comment No. 210-NFPA 855-2024 [Section No. 6.1.1]

6.1.1

ESSs shall be evaluated and confirmed for proper operation by the system owner or their designated agent.

6.1.1.1

Lead-acid and nickel-cadmium battery systems less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76battery requirements shall be permitted to have a commissioning plan complying with recognized industry practices in lieu of complying with 6.1.5.2.

6.1.1.2*

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations under the exclusive control of the electric utilities and located in building spaces or walk-in units used exclusively for such installations shall be permitted to have a commissioning plan in accordance with applicable governmental laws and regulations in lieu of developing a commissioning plan in accordance with 6.1.5.2.

6.1.1.3

Lead-acid and nickel-cadmium battery systems that are used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located in building spaces or walk-in units used exclusively for such installations shall be permitted to have a commissioning plan in accordance with applicable governmental laws and regulations in lieu of developing a commissioning plan in accordance with 6.1.5.2.

Statement of Problem and Substantiation for Public Comment

Addition of Commissioning exemption for lead-acid and nickel-cadmium rail control analogous to electric utility and telecom options for commissioning suggested by TG 24.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 211-NFPA 855-2024 [Section No. 8.1]	

Related Item

- TG 24

Submitter Information Verification

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Submittal Date:	Tue May 28 09:24:35 EDT 2024
Committee:	ESS-AAA

Public Comment No. 44-NFPA 855-2024 [Section No. 6.1.1]

6.1.1

ESSs shall be evaluated and confirmed for proper operation by the system owner or their designated agent.

6.1.1.1

~~Lead-acid and nickel-cadmium battery systems less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76battery requirements shall be permitted to have a commissioning plan complying with recognized industry practices in lieu of complying with~~ The requirements in 6.1. ~~5.2.~~ 1 shall not apply to traditional standby power applications.

6.1.1.2*

~~Lead~~ The requirements in 6.1.1 shall not apply to lead -acid and nickel-cadmium ~~battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations under the exclusive control of the electric utilities and located in building spaces or walk-in units used exclusively for such installations shall be permitted to have a commissioning plan in accordance with applicable governmental laws and regulations in lieu of developing a commissioning plan in accordance with 6.1.5.2~~ . batteries listed to UL1973 in systems 600 V dc or less.

Statement of Problem and Substantiation for Public Comment

The change seeks to make the lead-acid and nickel-cadmium exemptions more uniform in the various sections and broaden them to address UL 1973 listed products, and flooded cells in traditional standby power applications which have not required listing in the past.

Related Item

- FR-147

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Committee: ESS-AAA

Public Comment No. 251-NFPA 855-2024 [New Section after 6.1.2]

6.1.3

Fire protection and life safety systems shall be tested prior to commissioning the remainder of the ESS components.

6.1.3.1

Where installations involve two or more fire protection and life safety systems, they may be tested in parallel to the commissioning of the remaining ESS components where a fire watch is assigned during commissoning activities.

Statement of Problem and Substantiation for Public Comment

Ideally, fire protection and life safety systems would be tested prior to moving energy through an ESS. This adds clarity for both the AHJ and installer. However, for very large and complex systems requiring multiple fire systems, months can be spent troubleshooting and testing fire protection and life safety systems, not to mention, troubleshooting between the ESS OEM and the balance of plant fire system to ensure proper sequence of operations. The allowance of a fire watch for more complex systems provides fire protection and life safety while multiple teams of people can be working on all parts of the ESS system prior to final AHJ inspection and approval.

Related Item

- FR 97

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Public Comment No. 249-NFPA 855-2024 [Section No. 6.1.2]

6.1.2

System commissioning shall be conducted after the installation is complete <u>and ESS is energized</u> but prior to final <u>AHJ</u> inspection and approval.

Statement of Problem and Substantiation for Public Comment

Energization is required to commission the ESS systems which has not been clear in discussion with some AHJs. The complexity of large systems requires a parallel effort of energizing and commissioning the ESS along with associated systems like the fire protection, inverters, security, communications, etc. in order to meet the new requirements of Section 9.6.4. It also makes the process easier for AHJs to come out for inspections and approvals once the entire ESS facility has been commissioned. To that end, the additional clarification that AHJs shall do the inspections was added.

Related Item

- FR 97

Submitter Information Verification

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Public Comment No. 212-NFPA 855-2024 [Section No. 7.1.1]

7.1.1 Electric Utilities Under NERC Jurisdiction.

7.1.1.1

Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements.

7.1.1.2

Electric utilities ~~under NERC jurisdiction shall not be required to follow manufacturer's instructions~~ , communications utilities and rail transportation authorities shall be permitted to follow industry specific requirements and practices for lead-acid and nickel-cadmium battery systems ~~that are~~ used ~~for dc power for control of substations and control or shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations~~ in standby power or control applications in lieu of manufacturer's instructions and operation and maintenance documentation .

Statement of Problem and Substantiation for Public Comment

TG 24 output. Consider revision to expand the operation and maintenance exemption to telecom and rail. Like electric utility NERC rules, telecom has application specific maintenance and operations requirements that may override manufacturer's generic guidance. An example of this is ATIS 0600035.2018, Recommended Maintenance Routines and Frequencies for Central Office Backup Power. Rail may have similar internal practices.

Related Item

- TG 24

Submitter Information Verification

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Submittal Date: Tue May 28 09:38:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 45-NFPA 855-2024 [Section No. 7.1.1]

7.1.1 Electric Utilities Under NERC Jurisdiction.

7.1.1.1

Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements.

7.1.1.2

Electric utilities under NERC jurisdiction shall not be required to follow manufacturer's instructions for traditional standby power applications.

7.1.1.3

Electric utilities under NERC jurisdiction shall not be required to follow manufacturer's instructions for lead-acid and nickel-cadmium ~~battery systems that are used for dc power for control of substations and control or shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations.~~ batteries listed to UL 1973 in systems 600 V dc or less.

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-18

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 203-NFPA 855-2024 [Section No. 7.1.3]

7.1.3 SDS for Hazardous Materials.

7.1.3.1

SDS for hazardous materials contained in the ESS shall be posted within sight of the disconnecting means of any ESS or at a location approved by the AHJ.

7.1.3.2

For ESSs located outdoors, a means shall be provided to protect the SDS from the weather.

7.1.3.3 *

ESS shall be provided with NFPA 704 placarding in accordance with all of the following:

(1) As required by the HMA

(2) As required by applicable Codes and standards

(3) As required by the AHJ

Statement of Problem and Substantiation for Public Comment

Task Group 28 was assigned the task of improving NFPA 704 through their PI process, as well as determining how to improve placement of NFPA 704 diamond placarding in NFPA 855. While the proper place for this PI is actually as a new subsection under 4.7.5, there were no PIs in the first round on that section. Because there was a PI on this section, we have placed the task group input here as the second best location for it. 13 PIs were put in for NFPA 704 to improve the messaging on the placard (and the placement) to help first responders to ESS locations. While NFPA 855 can't really cover the messaging portion (that belongs to 704), it can cover the best locations for NFPA 704 signage, and this input (along with PI 204 for the Annex material associated with it) aims to provide better guidance on placement of these diamond hazard placards.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 204-NFPA 855-2024 [Section No. A.7.1.2(5)]	Annex material for this PI
Public Comment No. 204-NFPA 855-2024 [Section No. A.7.1.2(5)]	

Related Item

- PI-234

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 20-NFPA 855-2024 [Section No. 7.2.5.3]

7.2.5.3

Updated information shall be transmitted to ~~emergency responders if~~ the AHJ if the recommissioned system presents a change in the hazard.

Statement of Problem and Substantiation for Public Comment

Correspondence on changes to the system should flow first to the AHJ so he or she can inform the first responders as necessary. As the system owner, I may not have a direct line of communication with the first responders.

Related Item

- FR-65

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Submittal Date:	Wed Mar 13 08:18:37 EDT 2024
Committee:	ESS-AAA

Public Comment No. 211-NFPA 855-2024 [Section No. 8.1]

8.1 Decommissioning Plan.

Prior to decommissioning, the owner of an ESS or their designated agent(s) shall prepare a written decommissioning plan complying with 8.1.3 that provides the organization, documentation requirements, and methods and tools necessary to indicate how the safety systems as required by this standard and the ESS and its components will be decommissioned and the ESS removed from the site.

8.1.1

Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that are in compliance with NFPA 76 shall be permitted to have a decommissioning plan in compliance with recognized industry practices in lieu of complying with 8.1.~~3~~ 4 .

8.1.2*

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations under the exclusive control of the electric utilities and located outdoors or in building spaces used exclusively for such installations shall be permitted to have a decommissioning plan complying with applicable governmental laws and regulations in lieu of complying with 8.1.4 .

8.1. 3

Lead-acid and nickel-cadmium battery systems that are used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations shall be permitted to have a decommissioning plan complying with applicable governmental laws and regulations in lieu of complying with 8 . 1.4 .

8.1.~~3~~ 4 *

The decommissioning plan shall be provided to the AHJ and include the following information:

(1) An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned

(2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site

(3) The version of the decommissioning plan submitted during the permitting process

(4) Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained

(5) A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time

(6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned

(7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports

(8) A description of how any changes to the surrounding areas and other systems adjacent to the ESS, including, but not limited to, structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed

Statement of Problem and Substantiation for Public Comment

Expand decommissioning options for telecom and electric utility to cover rail as well. Recommended by TG 24 Exemption Task Group.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 210-NFPA 855-2024 [Section No. 6.1.1]	Same concern

Related Item

- TG 24

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Committee: ESS-AAA

Public Comment No. 46-NFPA 855-2024 [Section No. 8.1]

8.1 Decommissioning Plan.

Prior to decommissioning, the owner of an ESS or their designated agent(s) shall prepare a written decommissioning plan complying with 8.1.3 that provides the organization, documentation requirements, and methods and tools necessary to indicate how the safety systems as required by this standard and the ESS and its components will be decommissioned and the ESS removed from the site.

8.1.1

~~Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces or walk-in units used exclusively for such installations that are in compliance with NFPA 76 shall be permitted to have a decommissioning plan in compliance with recognized industry practices in lieu of complying with~~

The requirements in 8.1.3 shall not apply to traditional standby power applications .

8.1.2*

~~Lead~~ The requirements in 8.1.3 shall not apply to lead -acid and nickel-cadmium ~~battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations under the exclusive control of the electric utilities and located outdoors or in building spaces used exclusively for such installations shall be permitted to have a decommissioning plan complying with applicable governmental laws and regulations in lieu of complying with 8.1.3 .~~ batteries listed to UL1973 in systems 600 V dc or less. .

8.1.3*

The decommissioning plan shall be provided to the AHJ and include the following information:

(1) An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned

(2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site

(3) The version of the decommissioning plan submitted during the permitting process

(4) Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained

(5) A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time

(6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned

(7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports

(8) A description of how any changes to the surrounding areas and other systems adjacent to the ESS, including, but not limited to, structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-151

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Committee:	ESS-AAA

Public Comment No. 335-NFPA 855-2024 [Section No. 8.1.3]

8.1.3*

The decommissioning plan shall be provided to the AHJ and include the following information:

(1) An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned

(2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site

(3) The version of the decommissioning plan submitted during the permitting process

(4) Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained

(5) A detailed description of each activity to be conducted during the decommissioning process and who will perform that activity and at what point in time

(6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned

(7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports

(8) A description of how any changes to the surrounding areas and other systems adjacent to the ESS, including, but not limited to, structural elements, building penetrations, means of egress, and required fire detection and suppression systems, will be protected during decommissioning and confirmed as being acceptable after the system is removed

(9) Where a fire or other event has damaged the ESS and ignition or reignition of the ESS is possibe, the decommissioning plan shall include additional roles and responsibilities outlined in 9.6.7 and storage requirements of Chapter 14

Statement of Problem and Substantiation for Public Comment

Added verbiage to tie back Remediation addition and storage

Related Item

• FR-146 • Public Input No. 367-NFPA 855-2023

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Committee: ESS-AAA

Public Comment No. 194-NFPA 855-2024 [Section No. 9.1.5]

9.1.5 Fire and Explosion Testing.

9.1.5.1*

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, thermal runaway propagation potential at a module level, and thermal runaway propagation potential between ~~containers~~ ESS .

9.1.5.1.1

Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when they are installed with a charging system that is listed to UL 1012, UL 1741, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778.

9.1.5.1.2*

Where cell thermal runaway results in the release of flammable gases during a cell- or module-level test, an additional ~~unit-level~~ large scale fire test shall be conducted involving intentional ignition of the vent gases to assess the ~~fire propagation~~ thermal runaway propagation hazard.

9.1.5.1.2.1* Large Scale Fire _ Test shall include the following requirements.

(1) The representative ESS tested shall match the intended installation configuration other than the addition of a failure mechanism utilized for thermal runaway propagation initiation.

(2) Safety systems are not engaged.

(3) The large-scale fire testing

~~in accordance with 9.1.5.1.2~~

(1) shall be conducted or witnessed and reported by an approved testing laboratory

~~to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.~~

(1) .

A.9.1.5.1.2 Changes in an installation configuration, including the internal architecture of modules and units, that don't match the parameters tested, such as size and separation, cell type, or energy density, should not be accepted unless it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might not have been evaluated in the test.

~~Proposed spacing between cabinets for outdoor ESS installations consisting of multiple cabinets shall be validated using large-scale fire testing in accordance with Section 9.1 and~~

_ **9.1.5.1.2.2**

_

Large Scale Fire Test shall include the following evaluations.

(1) Performance criteria

  (2) If the adjacent unit is not fully populated, including cells at 100%SOC, no penetration of flames or flammable gas into adjacent unit can occur.

  (3) if the adjacent unit is fully populated, including cells at 100%SOC, no thermal runaway events of cells in the adjacent unit can occur.

(4) Proposed spacing between Finished product configuration of BESS for outdoor and indoor applications.

(5) Fire and damage impact on critical safety systems of the intiating unit.

(6) Survivability of the communication pathways.

(7) Fire Impingement and damage to adjacent ESS

  (8) Evaluate _ Combustibles – “Involve”

  (9) Evaluate _ Non-combustibles – “Effect"

(10) The collected data shall be reviewed by a registered design professional to verify that

~~complete combustion~~

(1) large scale fire condition of one

~~cabinet shall~~

(1) ESS

  (2) shall not result in Thermal Runaway propagation to adjacent

~~cabinets.~~

~~9.1.5.1.3~~ * –

~~The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation~~

(1)

  (a) ESS for location with exposures or

  (b) Shall be used to evaluate appropriate risk for specific locations .

9.1.5.1.4 * _

The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets.

9.1.5.

~~1.5~~ –

~~When cell thermal runaway results in the release of flammable gases during a cell- or module-level test, a unit-level test shall be conducted involving intentional ignition of the vent gases to assess the explosion hazard.~~

~~9.1.5.~~

2 * _ Test Reports.

9.1.5.2.1 _

The complete test report and its supporting data shall be provided to the AHJ for review and approval.

9.1.5.2.2 _

The test report shall be accompanied by a supplemental report prepared by a registered design professional with expertise in fire protection engineering that provides interpretation of the test data in relation to the installation requirements for the ESS.

Statement of Problem and Substantiation for Public Comment

As the PI from TG 4 recommended separating 9540A and large scale testing as two separate requirements. No clear path was provided from the requirements of large scale testing. Coordination efforts between UL and 855 have provided a initial pathway for definition and requirements of a large scale test. They have been added by TG 9 sub group

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 144-NFPA 855-2024 [New Section after 3.3.39]	
Public Comment No. 146-NFPA 855-2024 [New Section after 3.3.39]	
Public Comment No. 195-NFPA 855-2024 [Section No. A.9.1.5.1.3]	
Public Comment No. 197-NFPA 855-2024 [Section No. A.9.1.5.1]	

Related Item

- FR 139

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Committee:	ESS-AAA

Public Comment No. 285-NFPA 855-2024 [Section No. 9.1.5]

9.1.5* Fire and Explosion Testing.

9.1.5.1*

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers.

9.1.5.1.1

Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when they are installed with a charging system that is listed to UL 1012, UL 1741, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778.

9.1.5.1.2*

Where cell thermal runaway results in the release of flammable gases during a cell- or module-level test, an additional unit-level test shall be conducted involving intentional ignition of the vent gases to assess the fire propagation hazard.

9.1.5.1.2.1

The large-scale fire testing in accordance with 9.1.5.1.2 shall be conducted or witnessed and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.

9.1.5.1.2.2

Proposed spacing between cabinets for outdoor ESS installations consisting of multiple cabinets shall be validated using large-scale fire testing in accordance with Section 9.1 and reviewed by a registered design professional to verify that complete combustion of one cabinet shall not result in propagation to adjacent cabinets.

9.1.5.1.3*

The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation.

9.1.5.1.4*

The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets.

9.1.5.1.5

When cell thermal runaway results in the release of flammable gases during a cell- or module-level test, a unit-level test shall be conducted involving intentional ignition of the vent gases to assess the explosion hazard.

9.1.5.2* Test Reports.

9.1.5.2.1

The complete test report and its supporting data shall be provided to the AHJ for review and approval.

9.1.5.2.2

The test report shall be accompanied by a supplemental report prepared by a registered design professional with expertise in fire protection engineering that provides interpretation of the test data in relation to the installation requirements for the ESS.

Additional Proposed Changes

File Name	Description	Approved
997_015_BESS_Full_Scale_Test_Standard.pdf	FRA guidance on Large Scale Testing	

Statement of Problem and Substantiation for Public Comment

With the separation of 9540A and Large Scale testing, further guidance is required. TG 9 and UL task groups are working to provide definitions and inspection and test plans requirements to guide the industry in what a large scale test should look like. This adds a Public document on guidelines for testing created by Fire Risk Alliance. We have approval to including this document from FRA.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 151-NFPA 855-2024 [Section No. 9.1.5.1.5]	

Related Item

- FR 139

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Committee: ESS-AAA

Guidelines for Failure Mode Testing of Battery Energy Storage Systems

Full-Scale Test Method for Evaluation of Fire Propagation and Deflagration Mitigation in Single and Multi-Level Systems

Revision 00

Prepared by Fire & Risk Alliance, LLC.

FRA Standard Number: 997-018

Issued: March 2024

Notice

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Revision Notes:

				Authored:	Reviewed:	Approved:
Revision 00	February 2024	Initial Release				

Contents

List of Acronyms

AHJ	Authority Having Jurisdiction
BESS	Battery Energy Storage System
BMS	Battery Management System
DH	Deflagration Hazard
DT	Deflagration Testing
DUT	Device Under Test
EODV	End of Discharge Voltage
FID	Flame Ionization Detector
FPT	Flaming Propagation Testing
GB	Gas Buildup
HFG	Heat Flux Gauge
HRR	Heat Release Rate
HVAC	Heating, Ventilation, and Air Conditioning
LEL	Lower Explosive Limit
LFP	Lithium Iron Phosphate
NDIR	Non-Dispersive Infrared
NMC	Nickel Manganese Cobalt
PCS	Power Conditioning System
SOC	State-of-Charge
VT	Ventilation Testing
WCFMT	Worst-Case Failure Mode Testing

1 Introduction/Motivation

All battery energy storage systems (BESS) present fire and explosion hazards associated with their failure. Standardized test methodologies, principally UL 9540A [1], exist in an attempt to assess these hazards. UL 9540A is designed to evaluate BESS safety at several levels of system construction: specifically at the individual cell level, module level (groupings of cells), unit level (groupings of modules), and installation level (grouping of units paired with installed mitigation systems).

At the unit level, UL 9540A testing involves initiating thermal runaway in a one or more cells and observing the resulting effects. In some cases, there is limited cell-to-cell propagation and a relatively small amounts of gas is produced. In other cases, flaming combustion is observed, and entire units are consumed. BESS system design plays a role in which outcome is observed, but randomness does as well; manufacturers may repeatedly test the same BESS design to UL 9540A methods, and achieve significantly different results each time.

These UL 9540A results inform the decisions of designers, developers, and Authority Having Jurisdiction (AHJs) on BESS products and installations. It is clear that UL 9540A test methods do not consistently produce worst-case failures in systems under test, and therefore may not fully capture the hazard associated with BESS product designs or provide sufficient detail to make decisions regarding site layout. As a result there is a need for a method which is able to consistently evaluate worst-case BESS hazards, so that designers, developers, and AHJs can make better-informed decisions.

This document describes such a method, developed and informed by extensive large-scale BESS testing experience. The methodology, which consists of a variety of large-scale gas dispersion, deflagration, and fire tests, is able to consistently induce worst-case failure modes - both deflagration and flaming propagation - in systems under test. As a result, this approach can provide increased confidence that the hazards associated with tested systems are more completely characterized.

The purpose of this document is to describe the overall methodology and provide general guidance on the tests contained within. The method is intended to supplement UL 9540A or equivalent standards. UL 9540A methods are valuable for evaluating the potential hazard associated with typical/usual failures, while this method expands the understanding of hazards to ensure that potential impacts can be appropriately accounted for to personnel and property.

2 Approach

The method, herein referred to as Worst-Case Failure Mode Testing (WCFMT), is based on a full exploration of two separate failure modes: (1) gas buildup/deflagration and (2) flaming propagation. By investigating each separately, a more complete understanding of the hazards associated with a BESS design can be established. When a BESS unit fails, one of two conditions is true: either flaming combustion is present; or it is not. Different hazards are presented in each case, both of which are important to understand. As indicated previously, it is not clear which scenario will occur during a failure; therefore, both possibilities need to be investigated.

When there is no flaming combustion during a unit failure, or when flaming combustion is delayed, a deflagration (subsonic explosion) hazard is present. Because released gas is not being consumed by combustion, it can build up within an enclosure until a combustible gas-air mixture is created. A deflagration will occur if ignition is triggered by electrical arcing or other means. This can result in the development of significant overpressure resulting in damage to the BESS enclosure and the potential creation of flying debris/shrapnel.

When there is flaming combustion during a unit failure, a flaming propagation hazard is present. Flaming combustion can lead to rapid propagation both internally within a unit (from module to module) and between units themselves. Both of these hazards present a potential risk to first-responder safety and property.

The methods designed to investigate the hazard associated with each failure mode are detailed below, beginning with gas buildup/deflagration hazards followed by a flaming propagation hazard.

2.1 Gas Buildup/Deflagration Hazard

To protect the units from explosive gas buildup, BESS manufacturers typically employ one of two methods of mitigation systems:

- Ventilation: Fans are installed to exhaust battery gas from within a BESS unit and replace it with fresh air drawn from outside the unit. Alternatively, roof panels are installed, which open automatically to allow battery gas to escape upwards. In both cases, system is triggered by alarm signals generated by gas sensors located within the unit.

- Pressure Relief: Panels are designed to break away (completely or swing open) from a BESS unit at relatively low internal pressures, which reduces the maximum over-pressure observed within the unit during a deflagration event. This design feature is sometimes paired with spark igniters designed to ignite pockets of flammable gas prior to the entire unit being filled with flammable gas.

The Gas Buildup/Deflagration Hazard (GB/DH) portion of the testing is designed to evaluate the effectiveness of these mitigation systems as installed in a BESS design. In a non-flaming gas release scenario, mitigation system effectiveness will determine the deflagration hazard presented. GB/DH testing is comprised of two main test methods: one to evaluate BESS units which use active ventilation systems (**Ventilation Testing**), and another to evaluate BESS units which use pressure relief systems (**Deflagration Testing**). There is also a third optional test (**Gas Dispersion Testing**) designed to inform manufacturers on the optimal placement of the gas sensors and spark igniters. A graphical depiction of the method is shown in Figure 1. A description of the test methods follows in the subsequent subsections.

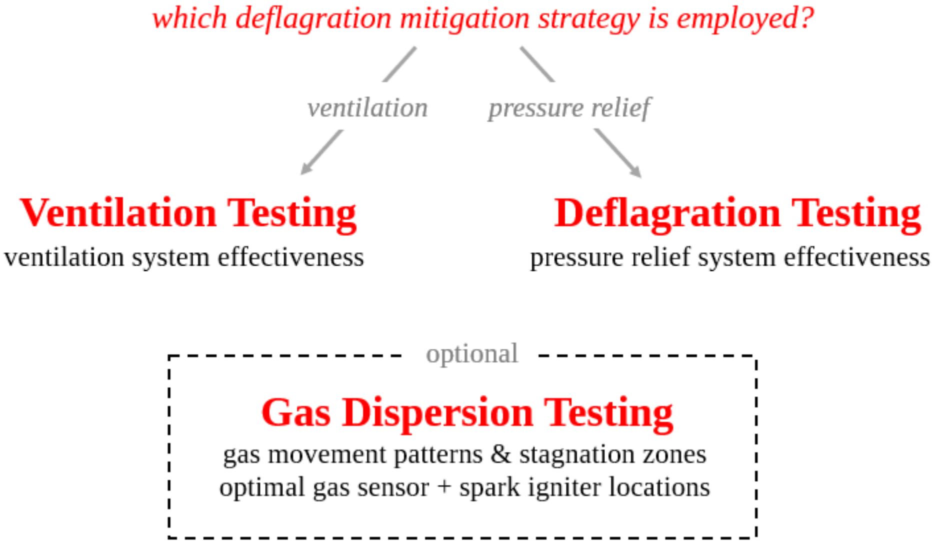


Figure 1: GB/DH Test Method

2.1.1 Ventilation Testing

Ventilation Testing (VT) should be performed for any BESS unit which employs ventilation-based mitigation strategies. It is designed to evaluate the ability of a BESS unit's ventilation system to manage a worst-case gas release event.

A gas blend, representative of cell gas produced and analyzed through UL 9540A cell testing, is injected into a BESS unit. The rate of injection should match the gas production rate observed in UL 9540A cell and module level testing, as monitored by calibrated mass flow controllers. The system should be tested under the least-favorable conditions. Therefore, gas should be released from a point within the unit which results in the slowest activation of the ventilation system - typically the point furthest away from manufacturer-integrated gas sensors. The ventilation system is allowed to activate once triggered by manufacturer-integrated sensors. The unit is thoroughly instrumented with a network of test-installed gas sensors; by this method, gas concentrations throughout the unit are known. The ventilation system is evaluated on its ability to maintain sufficiently low gas concentrations throughout the unit for the duration of the gas release such that no, or low pressure, deflagration occur. Low pressure deflagration refers to ignitions that do not challenge the integrity of the BESS unit and its components.

2.1.2 Deflagration Testing

Deflagration Testing (DT) should be performed for any BESS unit which employs pressure-relief-based mitigation strategies. It is designed to evaluate the ability of a BESS unit's pressure relief system to manage deflagrations of varying intensity.

Similar to VT testing in Section 2.1.1, a gas blend, representative of cell gas produced and analyzed through UL 9540A cell testing, is injected into a BESS unit. The rate of injection should match the gas production rate observed in UL 9540A cell and module level testing, as monitored by calibrated mass flow controllers. The unit is thoroughly instrumented with test-installed gas sensors. Gas is injected until the average concentration within the unit reaches 100% LEL. A deflagration is initiated by activation of spark igniters. Resulting pressure effects are measured by high-speed camera video recordings and dynamic pressure measurements at acquisition rates of at least 1 kHz. If the BESS unit is in sufficiently good condition following a deflagration event (structural integrity is maintained), new pressure relief panels are installed and the test is repeated. The gas concentration at ignition should be increased by 25% LEL for each subsequent test until a stoichiometric concentration is tested. A stoichiometric concentration is expected to result in the highest overpressure event following ignition. If the BESS unit's mitigation design incorporates spark igniters, they are allowed to activate once triggered by manufacturer integrated sensors.

2.1.3 Gas Dispersion Testing

Gas Dispersion Testing (GDT) is an optional test designed to inform manufacturers on the optimal locations for gas sensors and/or spark igniters within a BESS unit.

Similar to VT and DT testing in Sections 2.1.1 and 2.1.2, a gas blend, representative of cell gas produced and analyzed in UL 9540A cell testing, is injected into a BESS unit. The rate of injection should match the gas production rate observed in UL 9540A cell and module level testing, as monitored by calibrated mass flow controllers. The unit is thoroughly instrumented with test-installed gas sensors. The test is repeated by varying the gas injection locations. Gas movement patterns and stagnation zones are identified for each release location. Readings are recorded from both test-installed and manufacturer-integrated sensors.

2.2 Flaming Propagation Hazard

The methods designed to explore non-flaming hazards have been described in Section 2.1. This section focuses on methods to investiage flaming propagation hazards.

Flaming Propagation Testing (FPT) is designed to evaluate the dynamics of and hazard presented by intra-unit (module-to-module) and inter-unit (unit-to-unit) flaming propagation.

Worst-case BESS flaming propagation is characterized by the following scenario: a module within a BESS unit is exposed to a flame, either by ignition of vent gas from a cell within a module, or by an external flame source. The exposed module is located near the bottom of the unit, as flame spread will occur more readily in the upward vertical direction rather than laterally or vertically downward. A significant path for oxygen ingress is present during the test via a penetration in the unit exterior, opening of the unit doors, or other causes.

FPT aims to reproduce the above described scenario, quantify aspects of the resulting heat release and heat exposure, and empirically evaluate whether or not unit-to-unit propagation will occur in the planned unit installation configuration. Computational fire modeling is often an integral part of assessing the flaming propagation hazard associated with a BESS installation. Thus, FPT also aims to generate high quality information for use as inputs in these models, as well as a method to validate unit-to-unit spread modeling results.

The method is comprised of three tests: (1) evaluate intra-unit propagation (**Single Unit FPT**), (2) investigate lateral unit-to-unit propagation (**Multi-Unit FPT**), and (3) investigate vertical unit-to-unit propagation (**Stacked FPT**).

A graphical depiction of the method is shown in Figure 2. A description of the test methods is presented in the following subsections.

2.2.1 Single Unit Flaming Propagation Test

Single Unit FPT is intended to evaluate intra-unit module-to-module flame propagation, as well as provide quality inputs for use in computational fire models.

Single Unit FPT involves exposing a module within a fully populated BESS unit to a flame, e.g. a premixed jet burner, and evaluating the resulting propagation. A significant path for oxygen ingress is created

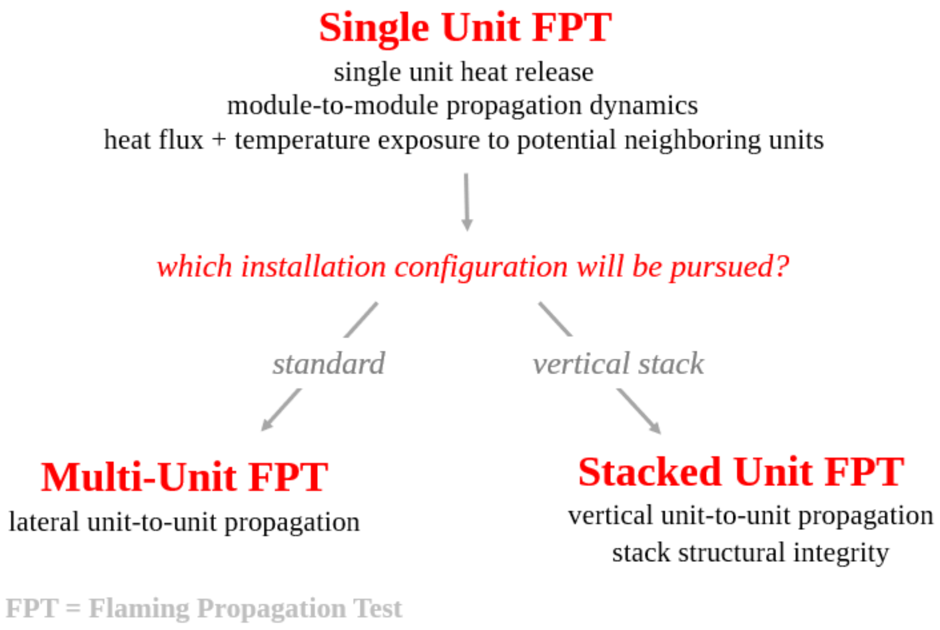


Figure 2: Flaming Propagation Hazard Method

into the unit, either by making penetrations in the unit exterior or by opening the unit doors. The inside of the unit is thoroughly instrumented with thermocouples and gas sensors. Also, heat flux gauges and thermocouple trees are placed around the unit's exterior. Internal instrumentation provides information about module-to-module propagation, while external instrumentation provides information about boundary conditions experienced by potential neighboring units. An opportunity exists to perform the test under a calorimetry hood setup where heat release rate and gas concentration could be measured, since only a single unit with a relatively small footprint is involved in the test. The heat release rate is another valuable input to the fire models.

2.2.2 Multi-Unit Flaming Propagation Test

Multi-Unit FPT should be performed on BESS units which are intended to be installed side-by-side with neighboring units. It is intended to provide empirical observations and measurements of lateral unit-to-unit propagation.

Multi-Unit FPT involves exposing a fully populated initiating BESS unit to a flame by the same method described for Single Unit FPT in Section 2.2.1. The initiating unit is surrounded on all sides by partially-populated target BESS units. The resulting unit-to-unit propagation (or non-propagation) is investigated as part of the test. Initiating and target units are thoroughly instrumented with thermocouples, gas sensors, and heat flux gauges.

2.2.3 Stacked Unit Flaming Propagation Test

Stacked Unit FPT should be performed on BESS units which are intended to be installed in a vertically-stacked configuration with neighboring units. It is intended to provide empirical observations and measurements of flaming propagation between BESS units stacked in a vertical configuration. BESS manufacturers are increasingly pursuing vertically stacked configurations in footprint-limited areas, and thus the associated hazard is important to understand.

Stacked FPT involves exposing a fully populated initiating BESS unit to a flame by the same methods utilized in Single and Multi-Unit FPT in Sections 2.2.1 and 2.2.2, respectively. A target unit is installed in a vertically stacked configuration above the initiating unit. The resulting unit-to-unit propagation (or non-propagation) is investigates as part of the test. Initiating and target units are thoroughly instrumented with thermocouples, gas sensors, and heat flux gauges.

3 Gas Buildup/Deflagration Hazard Test Methods

This section details the three test methods designed to evaluate BESS unit gas buildup/deflagration hazards.

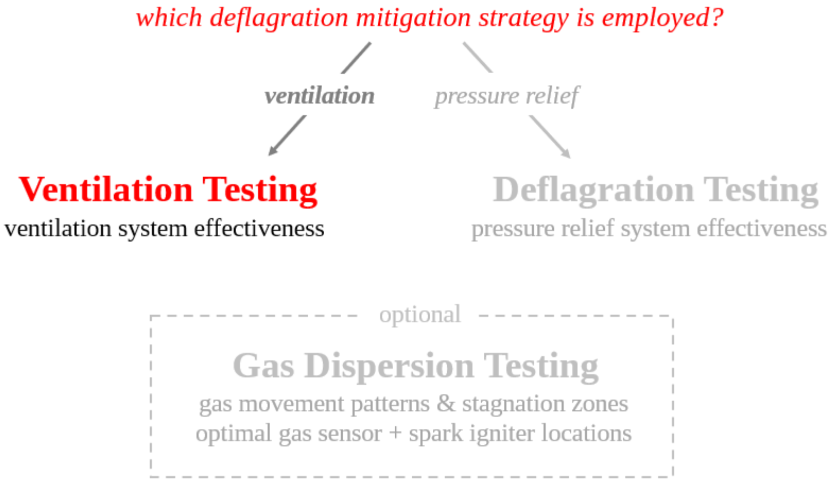
3.1 Ventilation Testing

Device Under Test (DUT): Single BESS unit, fully populated with dummy modules; active ventilation systems enabled

3.1.1 Overview

Ventilation Testing is designed to evaluate the ability of a BESS's active ventilation systems to mitigate a worst-case gas release event.

A gas blend, representative of the cell-level vent gas analyzed in UL9540A testing, is injected into the DUT. Gas concentration and movement are tracked by a network of sensors. Active ventilation systems are enabled but initially offline; they are triggered when gas is detected by manufacturer-integrated sensors. The ability of the ventilation system to keep global gas concentrations within the DUT below a critical threshold is evaluated. The test is repeated for several injection locations.



3.1.2 Setup/Instrumentation

Ventilation testing requires proper selection of three elements: (1) the gas blend injected into the DUT, (2) the location and method by which the gas is injected, and (3) the location and type of sensors used to detect the gas. The following considerations should be made when selecting for each:

- Gas Blend
  - Composition: Composition of the gas blend injected during testing should be representative of that analyzed during UL9540A cell-level testing.
- Gas Delivery
  - Plumbing: Gas injection system should be plumbed such that the DUT can be fully closed/sealed during testing
  - Injection Location: Gas should be injected at locations furthest from manufacturer-integrated gas sensors.

  - Rate & Volume: Gas delivery rate should represent gas production rate observed in UL9540A cell and module level testing. Gas flow should be controlled and monitored via calibrated mass flow controllers.

- Gas Sensors

  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.
  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less
  - Location: Sensors should be placed to ensure thorough coverage/sufficient spatial resolution across the entire DUT volume. See Figure 3 for an example of thorough sensor placement.

3.1.3 Procedure

The general procedure is as follows:

1. Instrument DUT with gas sensors and gas delivery system. Ensure that automatic ventilation systems are enabled but initially offline.

2. Initiate data acquisition from gas sensors (including manufacturer-integrated sensors) in accordance with Section 5.

3. Begin flowing gas blend into DUT at rate consistent with production rate observed in 9540A cell and module level testing. Gas volume delivery should be monitored using calibrated mass flow controllers.

4. Monitor gas concentrations inside the DUT; the test is over once either (1) gas concentrations have reached a steady state for 5 minutes, or (2) total gas released into the unit corresponds to a 50% LEL mixture in the unit's free volume.

5. Purge the DUT with clean air until sensor readings return to background ambient measurements.

6. Repeat for several worst-case release locations.

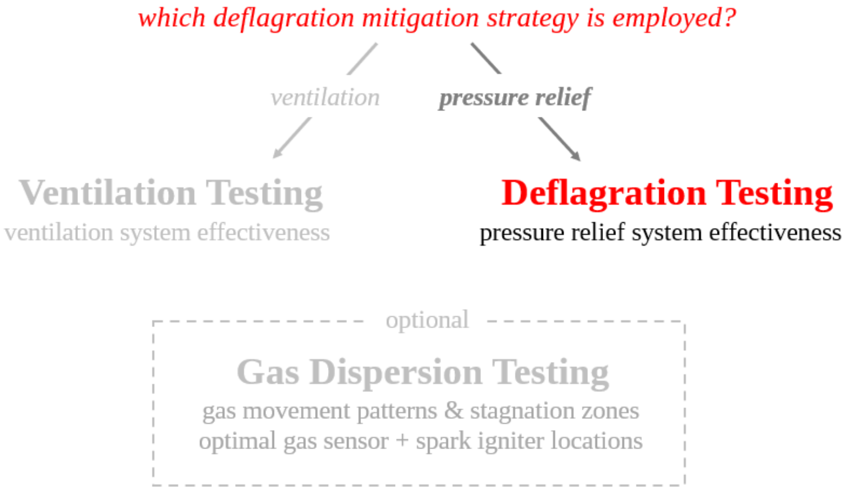
3.2 Deflagration Testing

DUT: Single BESS unit, fully populated with dummy modules; automatic deflagration mitigation systems enabled

3.2.1 Overview

Deflagration Testing is designed to evaluate the ability of a BESS unit's pressure relief systems to mitigate deflagrations of varying intensity.

A gas blend, representative of the cell-level vent gas analyzed in UL9540A testing, is injected into the DUT. Gas concentration and movement are tracked by a network of sensors. A deflagration is initiated by spark igniters once a volume of gas corresponding to a 100% LEL mixture has been injected. Resulting pressure effects are captured by high speed video and high capture-frequency pressure transducers. Any automatic intentional ignition systems are allowed to activate once triggered by manufacterer-integrated gas sensors.



3.2.2 Setup/Instrumentation

Deflagration Testing requires proper selection of several elements related to gas delivery and instrumentation. The following considerations should be made when selecting for each:

- Gas Blend
  - Composition: Composition of the gas blend injected during testing should be representative of that analyzed during UL9540A cell-level testing.
- Gas Delivery
  - Plumbing: Gas injection system should be plumbed such that the DUT can be fully closed/sealed during testing
  - Injection Location: If active ignition (purposeful triggering of manufacturer-integrated spark igniters upon detection of gas) is part of the DUT's pressure relief system design, gas should be injected at locations furthest from manufacturer-integrated gas sensors and spark igniters. If no active ignition present in the design, gas should be injected at locations furthest from pressure relief panels.
  - Monitoring: Gas volume delivery should be controlled and monitored via calibrated mass flow controllers.

- Gas Ignition System
  - Location: Spark igniters should be installed at a location which maximizes distance from pressure relief panels.
- Gas Sensors
  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.
  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less.
  - Location: Sensors should be placed to ensure thorough coverage/sufficient spatial resolution across the entire DUT volume. See Figure 3 for an example of thorough sensor placement.
- Pressure Transducers
  - Type: Pressure transducers should be of piezo-electric type and have a measurement rate of at least 1000 Hz
  - Location: Sensors should be placed to ensure sufficient spatial resolution across the entire DUT volume.
- High-Speed Video
  - Speed: Video should be recorded at a minimum of 240 frames per second.
  - Location: Cameras should be positioned to capture shots of pressure relief panels, unit doors, and at least two different angles of the unit exterior.

3.2.3 Procedure

The general procedure is as follows:

1. Instrument DUT with gas sensors, gas delivery system, ignition system, and pressure transducers. If automatic manufacturer-installed sparkers are part of the mitigation system design, ensure that they are enabled but initially offline.
2. Initiate data acquisition from gas sensors (including manufacturer-integrated sensors) in accordance with Section 5. Begin high-speed video recordings.
3. Begin flowing gas blend into DUT at rate consistent with production rate observed in 9540A cell and module level testing. Release location should promote mixing / diffusion. Terminate gas flow when volume delivered corresponds to a stoichiometric fuel-air mixture in the DUT's free volume. Gas volume delivery should be monitored using calibrated mass flow controllers.
4. Activate spark igniters; activation should be initiated within the first 10 seconds following termination of gas delivery.
5. If a deflagration occurs: terminate spark igniters. Purge the DUT with clean air. Monitor gas concentrations within the unit. Confirm that concentrations are below 10% LEL as indicated by all surviving gas sensors within the unit before approaching.
6. If no deflagration occurs: continue to activate spark igniters intermitently (at least once every 10 seconds) for 60 minutes following initial activation. If no deflagration has occurred after 60 minutes, terminate spark igniters. Continuosly purge the DUT with clean air. Monitor gas concentrations within the unit. Confirm that concentrations are below 10% LEL as indicated by all gas sensors within the unit before approaching.

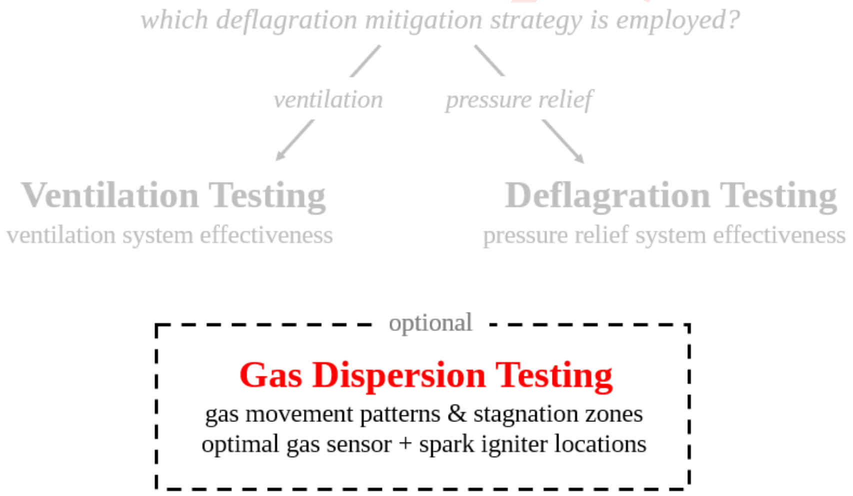
3.3 Gas Dispersion Testing

DUT: Single BESS unit, fully populated with dummy modules; active mitigation systems disabled

3.3.1 Overview

Gas Dispersion Testing is designed to identify gas movement patterns within BESS units in order to inform manufacturers on optimal placement for gas sensors and spark igniters.

A gas blend, representative of the cell-level vent gas analyzed in UL9540A testing, is injected into the DUT unit. Gas movement is tracked by a network of sensors. Automatic mitigation systems are disabled to allow more time for gas dispersion/movement. The test is repeated for several injection locations.



3.3.2 Setup/Instrumentation

Gas dispersion requires proper selection of three elements: (1) the gas blend injected into the DUT, (2) the method by which the gas is injected, and (3) the sensors used to detect the gas blend. The following considerations should be made when selecting for each:

- Gas Blend
  - Composition: Composition of the gas blend injected during testing should be representative of that analyzed during UL9540A cell-level testing.
- Gas Delivery
  - Plumbing: Gas injection system should be plumbed such that the DUT can be fully closed/sealed during testing
  - Injection Location: Release location should be varied for every test repetition.
  - Rate & Volume: Gas delivery rate should represent gas production rate observed in UL9540A cell and module level testing. Gas flow should be controlled and monitored via calibrated mass flow controllers.
- Gas Sensors
  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.

  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less
  - Location: Sensors should be placed to ensure thorough coverage/sufficient spatial resolution across the entire DUT volume. See Figure 3 for an example of thorough sensor placement.

3.3.3 Procedure

The general procedure is as follows:

1. Instrument DUT with gas sensors and gas delivery system. Ensure that automatic ventilation systems are disabled.
2. Initiate data acquisition from gas sensors (including manufacturer-integrated sensors) in accordance with Section 5.
3. Flow gas blend into DUT until total gas volume delivered corresponds to a mixture of 50% LEL in the DUT free-volume. Gas volume delivery should be monitored using calibrated mass flow controllers.
4. Monitor gas concentrations inside the DUT; once a steady state has been reached and maintained for 20 minutes, purge the DUT with clean air until sensor readings return to background ambient measurements.
5. Repeat for a variety of release locations.

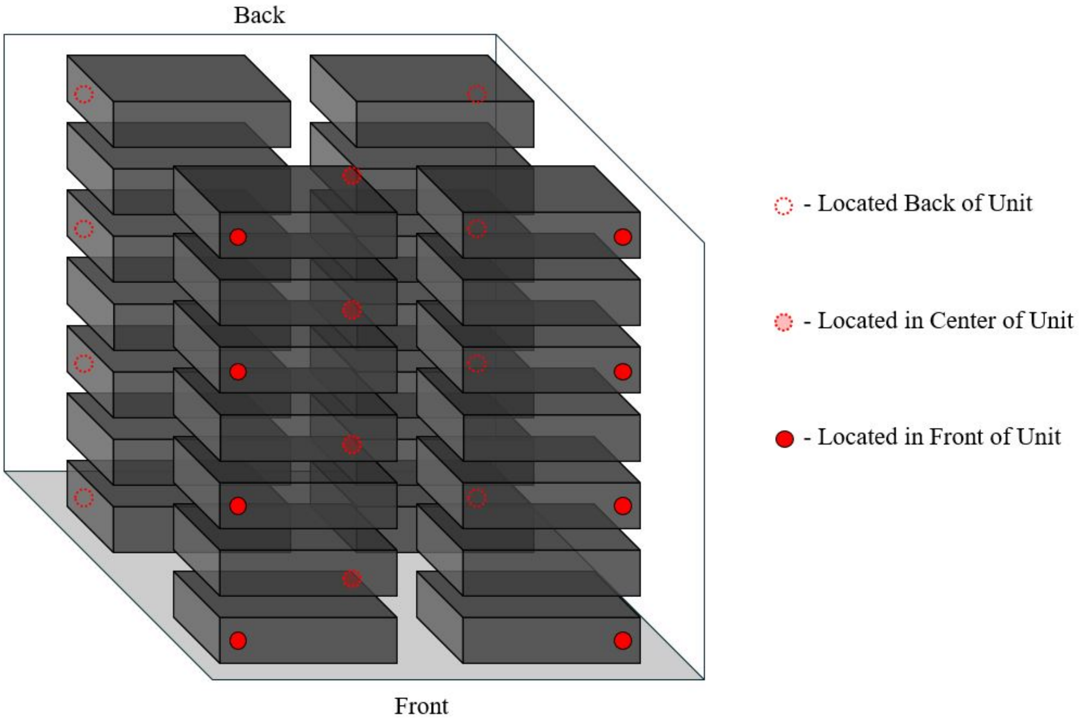


Figure 3: Example sensor placement for gas buildup/deflagration hazard tests

4 Flaming Propagation Test Methods

This section details the three test methods designed to evaluate BESS unit flaming propagation hazards.

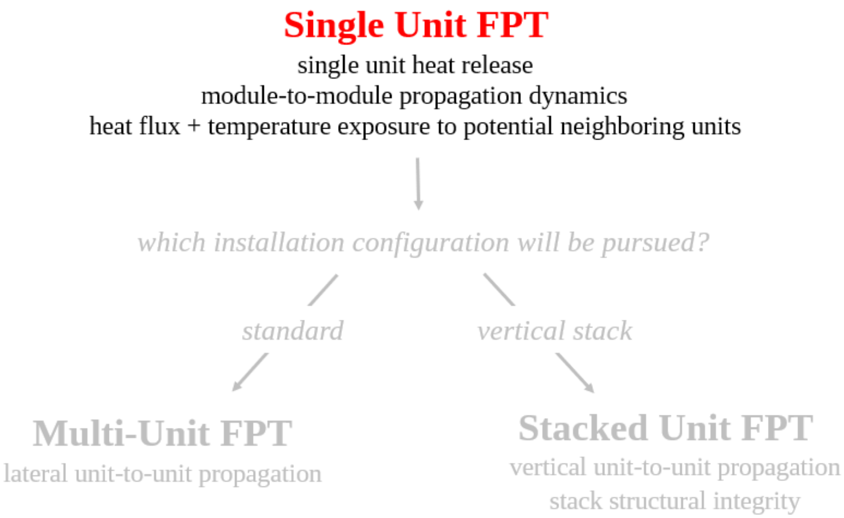
4.1 Single Unit FPT

DUT: Single BESS unit, fully populated with 100% SOC modules

4.1.1 Overview

Single Unit FPT is designed to evaluate the dynamics of module-to-module flaming propagation within a single BESS unit, as well as to provide quality inputs for use in computational fire models.

A module within the DUT is exposed to constant direct flame impingement by premixed burners. Burners are applied until the initiating module self-sustains flaming combustion. Resulting fire propagation throughout the DUT is observed. Unit doors are opened for the duration of testing to provide a significant path for oxygen ingress. The DUT, and modules contained within, are thoroughly internally instrumented with thermocouples. The DUT is surrounded on all sides by wall sections instrumented with arrays of thermocouples and heat flux gauges (see Figure 4). Internal instrumentation provides information about module-to-module spread dynamics and conditions within the unit. External instrumentation provides information about conditions experienced by potential neighboring units. The test should be performed under a ventilation hood/system with oxygen-consumption calorimetry capabilities so that heat-release rate measurements can be taken.



4.1.2 Setup/Instrumentation

Single Unit FPT requires proper selection of several elements related to gas delivery and instrumentation. The following considerations should be made when selecting for each:

- Premixed Burners
  - Location: Burners should be installed such that they directly expose the bottom of the initiating module to flaming. Initiating module should be chosen from the second-from-bottom row within the DUT to allow for investigation of downwards propagation.
  - Fuel: A stoichiometric air-methane mixture should be provided to the burners as fuel. Air and methane should be plumbed seperately, and mixed as they enter the burners. Air and methane delivery should be controlled and monitored via calibrated mass flow controllers.

- Instrumented Wall Sections
  - Position: Instrumented wall sections should represent potential neighboring units; each should have the same separation distance from the DUT exterior as neighboring units are planned to be installed.
- Thermocouples
  - Type: Thermocouples should be of type K.
  - Location: At a minimum, thermocouples internal to the DUT should be installed on each cell within the initiating module, each cell within the module above the initiator, and the exterior faces of each module within the DUT.
- Heat Flux Gauges
  - Type: All heat flux gauges should be water-cooled Schmidt-Boelter type gauges.
  - Location: Heat flux gauges should be installed within each instrumented wall section at several heights. They should be mounted such that their sensing surface is flush with the wall section.
  - Range:
- Gas Sensors
  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.
  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less.
  - Location: At a minimum, sensors should be placed in each corner of the DUT.

4.1.3 Procedure

The general procedure is as follows:

1. Instrument DUT with thermocouples, heat flux gauges, gas sensors. Position premixed burner system. Ensure that unit doors are opened and remain open for duration of testing.
2. Initiate data acquisition in accordance with Section 5.
3. Activate premixed burner system. Continuously apply burner flame to initiating module until self-sustaining combustion is observed.
4. Stop premixed burner gas supply. Allow module-to-module flaming propagation to progress unaided.
5. Terminate test once (1) flaming combustion is no longer observed and (2) all thermocouples within the DUT indicate decreasing temperatures lower than that of the thermal runaway temperature recorded in UL9540A cell-level testing.

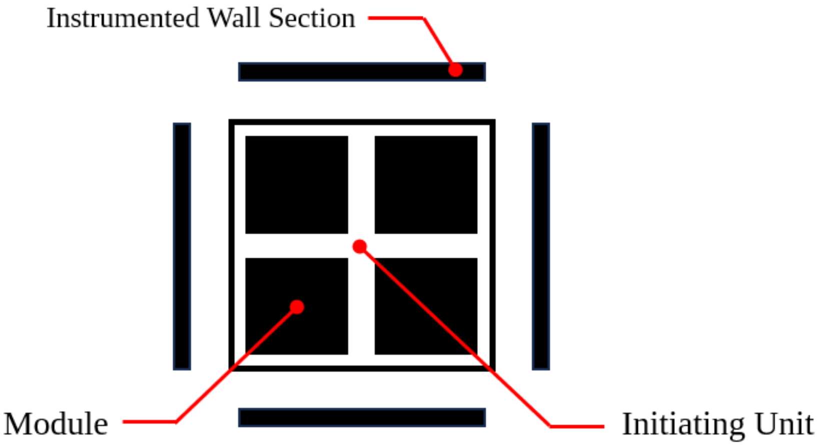


Figure 4: Single Unit FPT Layout (top down)

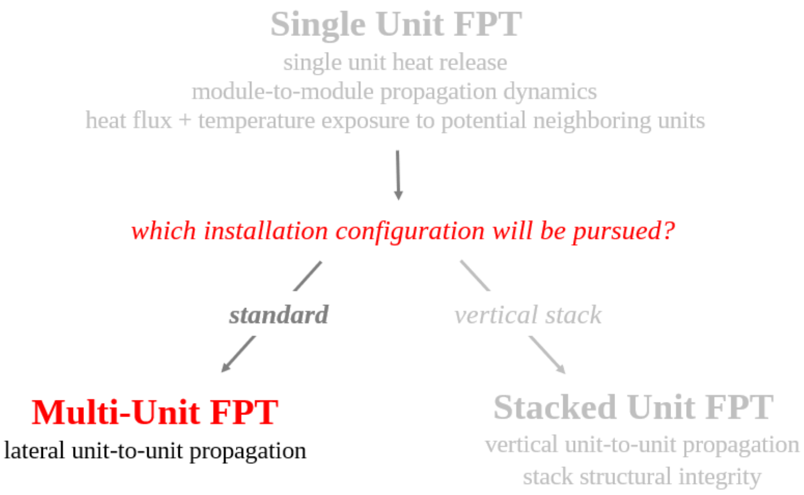
4.2 Multi-Unit FPT

DUTs: Initiating BESS unit, fully populated with 100% SOC modules; target BESS units which surround initiating unit, each partially populated with 100% SOC modules

4.2.1 Overview

Multi Unit FPT is designed to evaluate the potential for unit-to-unit flame propagation between BESS units installed in a lateral (side-by-side) configuration.

A fully populated BESS unit (initiating DUT) is surrounded on all sides by partially populated units (target DUTs). Target DUTs are populated only with those modules closest to initiating DUT (see Figure 5). A module within the initiating DUT is exposed to constant direct flame impingement by premixed burners. Burners are applied until the initiating module self-sustains flaming combustion. Resulting fire propagation throughout the initiating DUT and between initiating and target DUTs is observed. Initiating DUT doors are opened for the duration of testing to provide a significant path for oxygen ingress. The initiating and target DUTs, and modules contained within, are thoroughly internally instrumented with thermocouples and gas sensors.



4.2.2 Setup/Instrumentation

- Premixed Burners
  - Location: Burners should be installed such that they directly expose the bottom of the initiating module to flaming. Initiating module should be chosen from the second-from-bottom row within the DUT to allow for investigation of downwards propagation.
  - Fuel: A stoichiometric air-methane mixture should be provided to the burners as fuel. Air and methane should be plumbed seperately, and mixed as they enter the burners. Air and methane delivery should be controlled and monitored via calibrated mass flow controllers.
- Thermocouples
  - Type: All thermocouples should be type K.
  - Location: At a minimum, thermocouples internal to the initiating DUT should be installed on each cell within the initiating module, and the exterior faces of each target module.
- Heat Flux Gauges
  - Type: All heat flux gauges should be water-cooled Schmidt-Boelter type gauges.

  - Location: Heat flux gauges should be installed in first-responder pathways to gauge potential exposure.
  - Range:

- Gas Sensors
  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.
  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less.
  - Location: At a minimum, sensors should be placed in each corner of the DUT.

4.2.3 Procedure

1. Instrument initiating and target DUTs with thermocouples, heat flux gauges, and gas sensors. Position premixed burner system. Ensure that initiating DUT doors are opened and remain open for duration of testing.
2. Initiate data acquisition in accordance with Section 5.
3. Activate premixed burner system. Continuously apply burner flame to initiating module until self-sustaining combustion is observed.
4. Stop premixed burner gas supply. Allow flaming propagation to progress unaided.
5. Terminate test once (1) flaming combustion is no longer observed and(2) all thermocouples within initiating and target DUTs indicate decreasing temperatures lower than that of the thermal runaway temperature recorded in UL9540A cell-level testing.

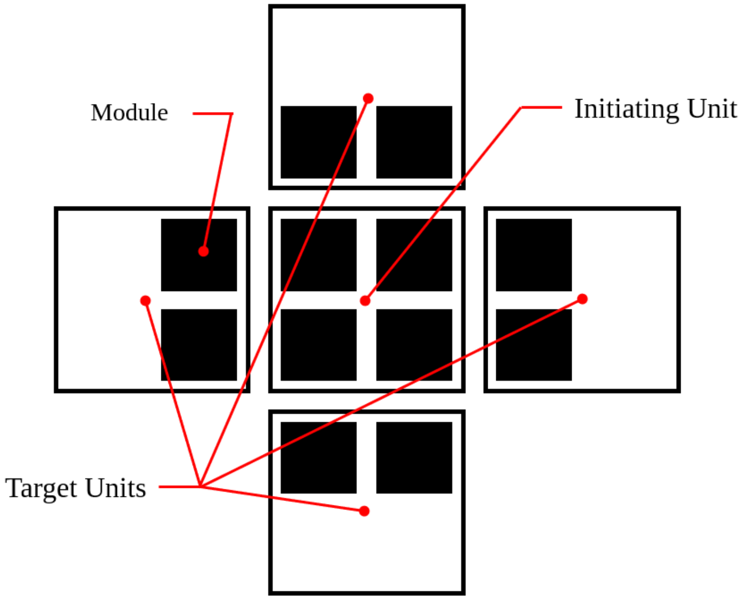


Figure 5: Multi-Unit FPT Layout (top down)

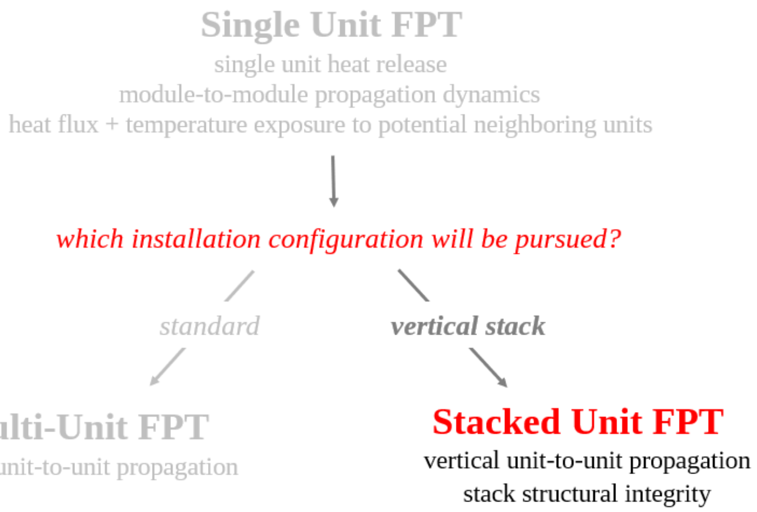
4.3 Stacked Unit FPT

DUTs: Initiating BESS unit, fully populated with 100% SOC modules; target BESS unit, mounted vertically above initiating unit, fully populated with 100% SOC modules

4.3.1 Overview

Stacked Unit FPT is designed to evaluate (1) the potential for unit-to-unit flame propagation between BESS units installed in a vertically-stacked configuration, and (2) the impact of a fire scenario on the integrity of the stacked structure.

A fully populated BESS unit (initiating DUT) is mounted on the ground. A second fully populated unit (target DUT) is mounted above the initiating DUT using the same mechanism/hardware which will be used in installations. A module within the initiating DUT is exposed to constant direct flame impingement by premixed burners. Burners are applied until the initiating module self-sustains flaming combustion. Resulting fire propagation throughout the initiating DUT and between initiating and target DUTs is observed. Initiating DUT doors are opened for the duration of testing to provide a significant path for oxygen ingress. The initiating and target DUTs, and modules contained within, are thoroughly internally instrumented with thermocouples and gas sensors. The exterior of the initiating DUT is also instrumented with strain gauges to monitor deformation.



4.3.2 Setup/Instrumentation

- Premixed Burners
  - Location: Burners should be installed such that they directly expose the bottom of the initiating module to flaming. Initiating module should be chosen from the second-from-bottom row within the DUT to allow for investigation of downwards propagation.
  - Fuel: A stoichiometric air-methane mixture should be provided to the burners as fuel. Air and methane should be plumbed seperately, and mixed as they enter the burners. Air and methane delivery should be controlled and monitored via calibrated mass flow controllers.
- Thermocouples
  - Type: All thermocouples should be type K.
  - Location: At a minimum, thermocouples internal to the initiating DUT should be installed on each cell within the initiating module, and the exterior faces of each target module.

- Heat Flux Gauges
  - Type: All heat flux gauges should be water-cooled Schmidt-Boelter type gauges.
  - Location: Heat flux gauges should be installed in first-responder pathways to gauge potential exposure.
  - Range: It is recommended that a range of gauges be used, for measurements related to life safety gauges should typically have a range of 0-15 kW/m^2. Those in place to monitor exposure conditions should typically have a broader range up to at least 50 kW/m^2. Ideally some analysis will have been conducted prior to the test to help guide the selection.
- Strain Gauges
  - Type: TBD
  - Location: Gauges should be placed on any primary or secondary structural members. The intent should be to ensure that prior to or during a collapse that the behavior of the structure is known.
- Gas Sensors
  - Species: Sensors should be designed to detect gas species which are predominant in the composition of the injected gas blend.
  - Measurement Range: Sensors should be ranged to able to measure twice the highest concentrations expected within the DUT, based on estimations of free volume and injected gas volume.
  - Response Time: Sensors should have a t_{90} response time on the order of 10 seconds or less.
  - Location: At a minimum, sensors should be placed in each corner of the DUT.

4.3.3 Procedure

The general procedure is as follows:

1. Instrument initiating and target DUTs with thermocouples, gas sensors, and strain gauges. Position premixed burner system. Ensure that initiating DUT doors are opened and remain open for duration of testing.
2. Initiate data acquisition in accordance with Section 5.
3. Activate premixed burner system. Continuously apply burner flame to initiating module until self-sustaining combustion is observed.
4. Stop premixed burner gas supply. Allow flaming propagation to progress unaided.
5. Terminate test once (1) flaming combustion is no longer observed and(2) all thermocouples within initiating and target DUTs indicate decreasing temperatures lower than that of the thermal runaway temperature recorded in UL9540A cell-level testing.

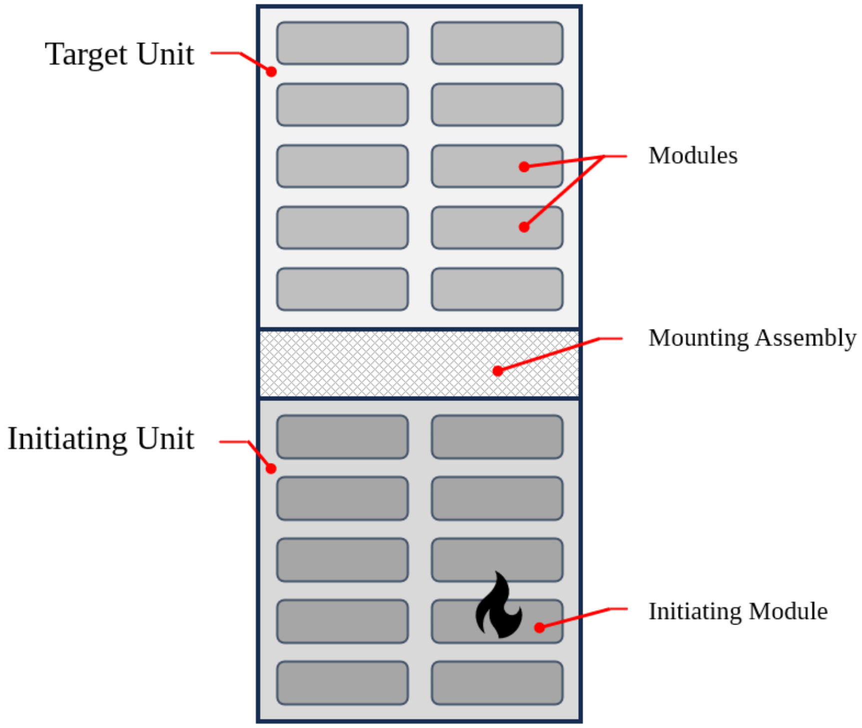


Figure 6: Stacked Unit FPT Layout (side view)

5 Standard Practices

The following is a collection of practices which should be implemented in all tests described within this document:

- At least 5 minutes of baseline/background data should be collected before test initiation.
- Relative humidity and temperature of the ambient test environment should be recorded using calibrated sensors for the duration of the test. If the test is outdoors, wind speed and direction should also be recorded.
- Video of the test should be recorded from multiple angles. If the test involves a potential deflagration, at least one high speed (240+ frames per second) video feed should be recorded.
- Test site layout and instrumentation should be well documented by photographs and schematics. The DUT should be photographed extensively before and after testing.
- All data from instrumentation should be collected at a minimum of 2 Hz. Measurements made to capture deflagration events should be taken at a minimum of 1 kHz.
- Gas analyzers employed for the purposes of HRR calculation should adhere to the measurement methods and ranges specified in Table 1. All sensors should be evaluated to ensure their applicability for the test. Consideration should be given to sensor response time, temperature and humidity effects, as well as cross-sensitivity to ensure accurate and timely data is collected.

Table 1: Gas measurement methodologies applied to unit test exhaust characterization.

Gases Measured	**Chemical Formula**	**Measurement Method**	**Measurement Range**
Oxygen	O_2	Paramagnetic analyzer	0 - 25 %vol
Carbon Monoxide	CO	NDIR analyzer	0 - 1 %vol
Carbon Dioxide	CO_2	NDIR analyzer	0 - 20 %vol
Hydrogen	H_2	Palladium-nickel thin film solid state sensor	0.4 - 5 %vol
Hydrogen	H_2	Catalytic sensor	0 - 4 %vol
Total Hydrocarbons	CH_4	FID	0 - 3 %vol

5.1 Glossary

The following definitions apply to this document:

- BATTERY ENERGY STORAGE SYSTEM (BESS) – Stationary equipment that receives electrical energy and utilizes batteries to store that energy for future use. A BESS, at a minimum, consists of one or more modules, a power conditioning system (PCS), a battery management system (BMS), and balance of plant components.
  - INITIATING BATTERY ENERGY STORAGE SYSTEM UNIT (INITIATING BESS) – A BESS unit which has been equipped with resistance heaters to create the internal fire condition necessary for the installation level test (Section 9).
  - TARGET BATTERY ENERGY STORAGE SYSTEM UNIT (TARGET BESS) –The enclosure and/or rack hardware that physically supports and/or contains the components that comprise a BESS that may be exposed to an initiating BESS.
- CELL – The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy.
- DEFLAGRATION - Combustion which propagates through a gas at subsonic speeds, driven by the transfer of heat.
- DEFLAGRATION PROTECTION SYSTEM - Deflagration protection systems either vent flammable gases prior to exceeding a flammable limit or the combustion gases following a deflagration event. These systems may also protect against over-pressure events. The mitigation strategies are designed such that damage is prevented or minimized to the enclosure.
- DETONATION - Combustion which propagates through a gas at supersonic speeds, driven by the transfer of heat.
- DUT – Device under test.
- ELECTRICAL RESISTANCE HEATERS – Devices that convert electrical energy into thermal energy.
- END OF DISCHARGE VOLTAGE (EODV) – The manufacturer's specified minimum voltage level during discharge.
- FLEXIBLE FILM HEATERS – Electrical resistance heaters of a film, tape or otherwise thin sheet-like construction that easily conform to the surface of cell.
- LOWER EXPLOSIVE LIMIT (LEL) - The lowest concentration of a flammable gas in air that will produce a flash or fire when an ignition source is present. The fuel-air mixture is too lean to ignite or burn below this limit.
- MAXIMUM SURFACE TEMPERATURE END-POINT – The final hold temperature measured on the cell case after conducting the thermal ramp when using the external heater method to achieve thermal runaway of the cell.
- MODULE – A sub-assembly that is a component of a BESS that consists of a group of cells or electrochemical capacitors connected together in a series and/or parallel configuration (sometimes referred to as a block) with or without protective devices and monitoring circuitry.
- STACKED - A configuration of BESS units in which a unit is placed directly above another unit. Structural support may be provided by the units themselves or via external/supplemental structural supports.
- STATE-OF-CHARGE (SOC) – The available capacity in a BESS, pack, module or cell expressed as a percentage of rated capacity.

- THERMAL RUNAWAY – An incident when the cell's temperature increases at an exponential rate due to self-heating of the cell's components/chemicals. The thermal runaway progresses when the cell's heat generation is higher than heat dissipation to the surroundings. A thermal runaway may lead to fire, explosion, and/or gas and smoke evolution.
- UNIT – A frame, rack or enclosure that consists of a functional BESS, which includes components and sub-assemblies such a cells, modules, BMS, ventilation devices, and other ancillary equipment.

References

[1] “Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems,” Standard ANSI/CAN/UL 9540A:2019, Underwriters Laboratories Inc., Northbrook, Illinois, 2019.

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Public Comment No. 47-NFPA 855-2024 [Section No. 9.1.5.1]

9.1.5.1*

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers.

9.1.5.1.1–

~~Lead~~

-

The requirements in 9.1.5.1 shall not apply to traditional standby power applications.

9.1.5.1.2

The requirements in 9.1.5.1 shall not apply to lead -acid and nickel-cadmium batteries

~~used~~

listed to UL1973 in

~~standby power systems and listed to UL 1973 shall not require UL 9540A testing when they are installed with a charging system that is listed to UL 1012, UL 1741, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778~~

systems 600 V dc or less .

9.1.5.1.~~2~~ 3 *

Where cell thermal runaway results in the release of flammable gases during a cell- or module-level test, an additional unit-level test shall be conducted involving intentional ignition of the vent gases to assess the fire propagation hazard.

9.1.5.1.~~2~~ 3 .1

The large-scale fire testing in accordance with 9.1.5.1.2 shall be conducted or witnessed and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.

9.1.5.1.~~2~~ 3 .2

Proposed spacing between cabinets for outdoor ESS installations consisting of multiple cabinets shall be validated using large-scale fire testing in accordance with Section 9.1 and reviewed by a registered design professional to verify that complete combustion of one cabinet shall not result in propagation to adjacent cabinets.

9.1.5.1.~~3~~ 4 *

The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation.

9.1.5.1.~~4~~ 5 *

The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets.

9.1.5.1.~~5~~ 6

When cell thermal runaway results in the release of flammable gases during a cell- or module-level test, a unit-level test shall be conducted involving intentional ignition of the vent gases to assess the explosion hazard.

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-125

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Submittal Date: Fri Mar 15 09:27:27 EDT 2024
Committee: ESS-AAA

Public Comment No. 106-NFPA 855-2024 [Section No. 9.1.5.1 [Excluding any Sub-Sections]]

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers.

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A or equivalent to collect data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers. For residential systems a large-sale fire test also shall be be conducted accordance with UL 9540B.

Statement of Problem and Substantiation for Public Comment

Previous versions of NFPA 855 stated that UL 9540A is the large scale fire test. The language changed from ". 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standard" to the above "UL 9540A and large-scale fire testing".
The "large scale fire testing" is not defined, specified or referenced in the standard. It is confusing and potentially will create issues for the industry. UL issued a large scale fire testing standard on May 10, 2024. (UL9540B). This new standard is specific and addressing only the residential ESS not bigger than 20 kWh.
Suggest to change the language with one or more of the items below:
a. remove the "and" use the same language as the previous edition used "UL 9540A or equivalent test standards"
b. specify or refer to a standard for the "large-sale" fire test
c. separate the residential units (below 20 kWh) from the commercial and utility systems (above 20 kWh), and require the "large scale-fire test" only for the residential systems.

Related Item

- first draft report

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 193-NFPA 855-2024 [Section No. 9.1.5.1 [Excluding any Sub-Sections]]

> Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, Thermal Runaway propagation potential at a module level, and Thermal Runaway propagation potential between ~~containers~~ ESS .

Statement of Problem and Substantiation for Public Comment

Incorporating the new definition from UL and added to 855 for Thermal Runaway Propogation.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 196-NFPA 855-2024 [Section No. A.9.1.5.1.2]	

Related Item

- FR 138

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 21-NFPA 855-2024 [Section No. 9.1.5.1 [Excluding any Sub-Sections]]

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance with UL 9540A and ~~large-scale fire testing to collect~~ include collection of data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers.

Statement of Problem and Substantiation for Public Comment

Improved grammar of first draft text. Also, large scale testing as used in the 2020 edition has been changed to fire and explosion testing. The proposed change makes more consistent the use of fire and explosion testing as these are defined in section 3. Using both terms in the same sentence implies there is a distinction between them which may not be the case.

Related Item

- FR-139

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Committee: ESS-AAA

Public Comment No. 252-NFPA 855-2024 [Section No. 9.1.5.1 [Excluding any Sub-Sections]]

Where required elsewhere in this standard, fire and explosion testing in accordance with 9.1.5 shall be conducted on a representative ESS in accordance ~~with UL 9540A and large-scale fire testing to~~ with **all applicable sections of** UL 9540A to collect data for gas production at a cell level, propagation potential at a module level, and propagation potential between containers.

Statement of Problem and Substantiation for Public Comment

Form Energy supports the development of large scale fire testing procedures for applicable chemistries but does not recommend calling it out as a separate test from UL 9540A.

Based on feedback from the large scale fire test working group within the UL 9540A technical committee, it is understood that the current plan is to include the new large scale fire test procedure as a part of UL9540A. Form Energy agrees that all test procedures (thermal runaway & flammable gas determination, cell-to-cell thermal runaway propagation, large scale fire testing, explosion testing, alternative chemistry tests) should be contained within the text of UL 9540A. The current wording of UL9540A and large scale fire testing implies that they are two separate tests and may cause confusion.

Related Item

- FR-139

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 166-NFPA 855-2024 [Section No. 9.1.5.1.1]

9.1.5.1.1

Lead-acid and nickel-cadmium batteries comprised of vented cells or cells listed to UL 1973 used in standby power systems ~~and listed to UL 1973~~ shall not require UL 9540A testing ~~when they~~ where they comply with one or more of the following:

(1) They are installed with a charging system that is listed to

~~UL 1012~~

UL 1012 , UL

~~1741, UL 60950~~

60950 -1, or

~~UL 62368-1, or a UPS listed to UL 1778~~

UL 62368-1

(2) They are installed with an inverter that is listed to UL 1741

(3) They are part of a UPS that is listed to UL 1778

(4) The are used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(5) They are used for control of f ixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(6) They are less than 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76 .

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggested simplifications are welcomed.

Related Item

- TG 24

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Submittal Date: Fri May 24 18:27:58 EDT 2024
Committee: ESS-AAA

Public Comment No. 22-NFPA 855-2024 [Sections 9.1.5.1.2.1, 9.1.5.1.2.2]

Sections 9.1.5.1.2.1, 9.1.5.1.2.2

9.1.5.1.2.1

The ~~large-scale~~ fire and explosion testing in accordance with 9.1.5.1.2 shall be conducted or witnessed and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.

9.1.5.1.2.2

Proposed spacing between cabinets for outdoor ESS installations consisting of multiple cabinets shall be validated ~~using large-scale fire~~ using fire and explosion testing in accordance with Section 9.1.5 and reviewed by a registered design professional to verify that complete combustion of one cabinet shall not result in propagation to adjacent cabinets.

Statement of Problem and Substantiation for Public Comment

Section 9.1.5.1.2.1 refers to large-scale testing in accordance with 9.1.5.2, but 9.1.5.2 is a mix of cell level, module level and unit level testing. If all need to be performed by an approved laboratory, we should categorize all as fire and explosion testing which is a defined term. Perhaps only the large scale or unit level testing is suitable for determination of gas composition, but if so, that is not made clear by the text. Similarly, 9.1.5.1.2.2 uses large scale testing, when perhaps we mean fire and explosion testing.

Reference to 9.1 in 9.1.5.1.2.2 should be 9.1.5.

Related Item

- FR-180

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 344-NFPA 855-2024 [Section No. 9.1.5.1.2.2]

9.1.5.1.2.2

Proposed spacing between ~~cabinets~~ enclosures for outdoor ESS installations consisting of multiple cabinets shall be ~~validated~~ analyzed using anticipated wind conditions and validated using large-scale fire testing in accordance with Section 9.1 and reviewed by a registered design professional to verify that complete combustion of one cabinet shall not result in propagation to adjacent ~~cabinets~~ enclosures .

Statement of Problem and Substantiation for Public Comment

Cabinet is a not a well-defined term and manufacturers may try to argue that what they sell is a container or cube or other box and not a cabinet.

A single fire test is only indicative of fire propagation performance for a single wind condition. Analysis should be provided to show that propagation is not expected for all reasonably expected wind conditions. An example of this problem is the Tesla Victoria Big Battery incident in which the test data showed no propagation but in the actual incident, different wind conditions led to propagation.

Related Item

- 9.1.5.1.2.1

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Committee:	ESS-AAA

Public Comment No. 237-NFPA 855-2024 [New Section after 9.1.5.1.3]

9.1.5.1.3.1 Use of stacked containers shall be allowed based on large scale fire test that the fire will not propagate beyond the stacked containers.

Statement of Problem and Substantiation for Public Comment

The industry is moving to tighter energy density, as such containers are being stacked on Girdscale sites, they are also be stack in barge configurations. this provides some guidance that they should be tested in that confirguration to determine protentional risks.

Related Item

- CI 183

Submitter Information Verification

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Submittal Date: Wed May 29 09:39:33 EDT 2024
Committee: ESS-AAA

Public Comment No. 70-NFPA 855-2024 [New Section after 9.1.5.1.3]

Commentary on CI-183 Stacked Containers

Statement of Problem and Substantiation for Public Comment

The term "container" is not defined. Stacked containers are either enterable and should be treated like buildings, or are not enterable and should be considered like rather large cabinets. I don't think the text of CI-183 is needed. Maybe best to have some text in the annex: Stacked containers that are enterable and should be treated as two-story buildings. Stacked containers that are not enterable should be considered cabinets.

Related Item

- CI-183

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Committee:	ESS-AAA

Public Comment No. 254-NFPA 855-2024 [New Section after 9.1.5.1.5]

9.1.5.1.6*

The test requirements outlined in Sections 9.1.5.1.2 through 9.1.5.1.5 are specific to chemistries that undergo thermal runaway, such as lithium ion. Alternative chemistries may have different procedures or exceptions based on the unique hazard profile. UL 9540A shall be referenced to determine the specific requirements for fire and explosion testing for alternative chemistries.

A.9.1.5.1.6

Examples of alternative chemistries with unique test procedures include aqueous chemistries such as lead-acid, nickel-cadmium, and iron-air.

Statement of Problem and Substantiation for Public Comment

The specific UL 9540A (and now “large scale fire test”) requirements throughout Section 9.1.5 do not reflect procedural differences or exceptions for non-lithium ion chemistries. These general requirements contradict the chemistry-specific procedures in UL 9540A. This may lead to confusion among AHJs and enforcement of unintended testing requirements for these alternative chemistries. It is recommended that acknowledgment of these different test procedures is included in the standard for clarity.

Related Item

- FR-189 • FR-141

Submitter Information Verification

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Submittal Date: Wed May 29 14:08:22 EDT 2024
Committee: ESS-AAA

Public Comment No. 151-NFPA 855-2024 [Section No. 9.1.5.1.5]

~~9.1.5.1.5~~ –

~~When cell thermal runaway results in the release of flammable gases during a cell- or module-level test, a unit-level test shall be conducted involving intentional ignition of the vent gases to assess the explosion hazard.~~

Statement of Problem and Substantiation for Public Comment

The requirement for a piloted ignition for explosion testing doesn't have a industry test plan requirement to meet this condition, recomend it be removed until 855 and UL can align on the methodology.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 285-NFPA 855-2024 [Section No. 9.1.5]	

Related Item

- FR 141

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Submittal Date: Fri May 24 14:35:53 EDT 2024
Committee: ESS-AAA

Public Comment No. 48-NFPA 855-2024 [Section No. 9.2.1]

9.2.1 Listing.

9.2.1.1

ESSs shall be listed in accordance with UL 9540, unless specifically exempted elsewhere in this standard.

9.2.1.2 Lead-Acid and Nickel-Cadmium Battery Systems.

9.2.1.2.1~~*~~ –

~~Lead-acid and nickel-cadmium batteries, where used in a stationary standby service with 600 V dc or less, shall be listed to UL 1973~~

The requirements in 9.2.1 shall not apply to traditional standby power applications .

9.2.1.2.2

~~Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778 and utilized for standby power applications, which are limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to be listed in accordance with UL 9540~~ The requirements in 9.2.1 shall not apply to lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less .

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-126

Submitter Information Verification

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Submittal Date: Fri Mar 15 09:28:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 112-NFPA 855-2024 [Section No. 9.2.1.1]

9.2.1.1

ESSs shall be listed in accordance with UL 9540, unless specifically exempted elsewhere in this standard.

For additional safety of the ESS, it is recommended that Battery Analytics software monitor the data produced by the Battery Management System (BMS).

Statement of Problem and Substantiation for Public Comment

UL 9540 is primarily addressing hardware design rules that are generally focused on periods where thermal runaway phenomena are already being exhibited (production of gases, intrinsic safety measures of battery cells, and high temperature detection, etc.). The reliability of the BMS is limited and has no redundancy in place. An additional layer of physics-based battery analytics allows for these phenomena to be detected up to months earlier than the BMS is capable, and can also alert the operator of a faulty BMS. For the moment, the BMS is a single point of failure in the ESS which poses a challenge in preventing safety events.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 108-NFPA 855-2024 [New Section after 9.2.2]	PI 248
Public Comment No. 110-NFPA 855-2024 [Section No. 4.4.4]	PI 248
Public Comment No. 111-NFPA 855-2024 [New Section after 3.3]	PI 248

Related Item

- PI 248

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 82-NFPA 855-2024 [Section No. 9.2.1.1]

~~**9.2.1.1**~~ –

~~ESSs shall be listed in accordance with UL 9540, unless specifically exempted elsewhere in this standard.~~

Statement of Problem and Substantiation for Public Comment

Section 9.2.1 is redundant to section 4.6.1 requirement for listing. Since chapter 9 doesn't modify this requirement of 4.6.1 is it not required in chapter 9.

Related Item

- PI 164

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 121-NFPA 855-2024 [Sections 9.2.1.2.1, 9.2.1.2.2]

Sections 9.2.1.2.1, 9.2.1.2.2

9.2.1.2.1*

Valve-Regulated Lead~~-acid and nickel-cadmium~~ Acid (VRLA) batteries, where used in a stationary ~~standby~~ service with ~~600 V~~ 1500 V dc or less, shall be listed to UL 1973 instead of UL 9540 .

9.2.1.2.2*

~~Lead~~ Vented lead -acid ~~battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778 and utilized for standby power applications, which are limited to not more than 10 percent of the floor area on the floor on which the ESS is located,~~ and vented nickel-cadmium batteries shall not be required to be listed ~~in accordance with UL 9540.~~ to UL 1973 or UL 9540.

Statement of Problem and Substantiation for Public Comment

Vented lead-acid batteries are the oldest and most mature of aqueous batteries in existence with millions of cells installed across a wide user base . Their proven safety record and aqueous electrolyte makes them the safest battery available. The voltage level is raised to 1500 Vdc as the dc voltage does not affect the internal safety of the battery. 1500 Vdc is now the standard limit for many applications using lead-acid batteries.

Related Item

- • 165

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Committee:	ESS-AAA

Public Comment No. 160-NFPA 855-2024 [Sections 9.2.1.2.1, 9.2.1.2.2]

Sections 9.2.1.2.1, 9.2.1.2.2

9.2.1.2.1*

~~Lead~~
The requirements in 9.2.1 shall not apply to lead -acid and nickel-cadmium

~~batteries,~~
batteries where used in a stationary standby service

~~with 600 V~~
consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

~~, shall be listed to UL 1973.~~

~~**9.2.1.2.2**~~ –

~~Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778 and utilized for standby power applications, which are limited to not more than 10 percent~~

(1)

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(6) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which

~~the ESS is located, shall not be required to be listed in accordance with UL 9540~~

(1) they are located .

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggest simplifications are welcomed.

Related Item

- TG 24

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Public Comment No. 108-NFPA 855-2024 [New Section after 9.2.2]

9.2.2.3

If the hazard mitigation analysis indicates evidence of abnormal electrochemical behavior within lithium-ion ESS sub-elements Battery Analytics Software shall be applied to monitor the ESS' safety for the duration of the project's operational life.

Statement of Problem and Substantiation for Public Comment

The hazard mitigation analysis that is capable of identifying early signs of future safety risks requires continuous monitoring to prevent the hazards from returning, worsening, or arising in other sub-components of the ESS. Performing an analysis at a single point in time will not be sufficient to prevent these concerns from presenting themselves in the future. Thus, continuous monitoring of the battery analytics software is required. Once these hazards are identified, the appropriate preventative maintenance or operation can be taken to mitigate the risk.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 107-NFPA 855-2024 [New Section after 9.2.1.1]	PI 248
Public Comment No. 110-NFPA 855-2024 [Section No. 4.4.4]	
Public Comment No. 111-NFPA 855-2024 [New Section after 3.3]	
Public Comment No. 112-NFPA 855-2024 [Section No. 9.2.1.1]	

Related Item

- PI 248

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Committee: ESS-AAA

Public Comment No. 49-NFPA 855-2024 [Section No. 9.2.3]

9.2.3 Energy Storage Management System (ESMS).

9.2.3.1*

Where required by the equipment listing in accordance with 4.6.1 or the hazard mitigation analysis in accordance with Section 4.4, an approved ESMS or BMS shall be provided for monitoring operating conditions and maintaining voltages, currents, and temperatures within the manufacturer's specifications.

9.2.3.2*

The ESMS or BMS shall electrically isolate the ESS or affected components of the ESS if potentially hazardous conditions are detected.

9.2.3.3*

When required by the AHJ, visible annunciation shall be provided on the cabinet exterior or in an approved location to indicate potentially hazardous conditions associated with the ESS exist.

9.2.3.4 Lead-Acid and Nickel-Cadmium Battery Systems.

9.2.3.4.1

~~Lead-acid and nickel-cadmium batteries listed to UL1973 in systems600 V dc or less, shall not be required to comply with~~ The requirements in 9.2.3 ~~.1 through~~ shall not apply to traditional standby power applications.

9.2.3.

~~3~~

4 . 2

The requirements in 9.2.3

~~.4.2~~

~~Lead~~ shall not apply to lead -acid and nickel-cadmium ~~battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778 and used in standby power applications shall not be required to comply with 9.2.3.1 through 9.2.3.3 .~~ batteries listed to UL1973 in systems 600 V dc or less .

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-127

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: ATIS
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City:

State:	
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Submittal Date:	Fri Mar 15 09:29:00 EDT 2024
Committee:	ESS-AAA

Public Comment No. 161-NFPA 855-2024 [Section No. 9.2.3.4]

9.2.3.4 Lead-Acid and Nickel-Cadmium Battery Systems.

9.2.3.4.1

~~Lead-acid and nickel-cadmium batteries listed to UL1973 in systems600 V dc or less, shall not be required to comply with~~
The requirements of 9.2.3.1 through 9.2.3.3

~~.~~

~~**9.2.3.4.2**~~ –

~~Lead~~
shall not apply to lead -acid and nickel-cadmium

~~battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778 and used in standby power applications shall not be required to comply with 9.2.3.1 through 9.2.3.3 .~~
batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(6) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggest simplifications are welcomed.

Related Item

- TG 24

Submitter Information Verification

Submitter Full Name: Richard Kluge

Organization: NEBScore Inc.
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Street Address:
City:
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Zip:
Submittal Date: Fri May 24 18:02:26 EDT 2024
Committee: ESS-AAA

Public Comment No. 23-NFPA 855-2024 [Section No. 9.2.4]

9.2.4 Repurposed, Remanufactured, and Refurbished Batteries.

9.2.4.1*–

~~This section shall apply to batteries that have been repurposed, remanufactured, or refurbished.~~

~~9.2.4.2~~ –

~~ESSs~~

ESSs containing repurposed, remanufactured, or refurbished batteries shall comply with all applicable requirements in this standard for an ESS containing new batteries.

9.2.4.~~3~~ –

~~Batteries that have been repurposed, remanufactured, or refurbished shall meet the applicable technology-specific requirements in Table 9.6.6 .~~

~~9.2.4.5~~ * –

~~Repurposed batteries, remanufactured batteries, and the refurbished batteries shall not be permitted unless the battery is repurposed by~~

~~9. 2.4.4~~ –

~~Refurbished batteries that are used in an application that differs from the original use, or have internal parts replaced or repaired, shall comply with both of the following:~~

(1) ~~Subsection 9.2.4 for remanufactured batteries~~

(2) ~~Subparagraphs 9.2.4.5 and 9.2.4.6~~

* Repurposed batteries shall be processed by a company that is listed in accordance with UL 1974

~~and the system using the~~

.

9.2.4.3 The ESS using repurposed, remanufactured, or refurbished batteries ~~complies with~~ shall comply with the listing requirements of Section 4.6.1.

9.2.4.~~6~~ 4 * – The repurposed , remanufactured, or

~~remanufactured batteries~~

refurbished batteries , modules,

~~and~~

or cells shall be provided with a nameplate marking that includes the electrical ratings, chemistry, model number, and manufacturer's identification.

Statement of Problem and Substantiation for Public Comment

Edited to remove redundant text. Note that UL 1974 scope (see below) is only for repurposed batteries. UL 1974 excludes remanufactured and refurbished batteries (see 1.3 below), so those are removed from the obligation to be processed by a UL 1974 facility.

UL-1974.1

Evaluation for Repurposing Batteries
ANSI/CAN/UL 1974
1 Scope
1.1 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 propulsion, and that are intended for a repurposed use application, such as for use in energy storage systems and other applications for battery packs, modules, cells and electrochemical capacitors.

1.2 This standard also covers application specific requirements for repurposed battery packs/systems and battery packs/systems utilizing repurposed modules, cells and other components.

1.3 This standard does not cover the process for remanufactured batteries, which are also referred to as refurbished or rebuilt batteries.

Related Item

- FR-144

Submitter Information Verification

Submitter Full Name: Richard Kluge
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City:
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Submittal Date: Wed Mar 13 10:59:16 EDT 2024
Committee: ESS-AAA

Public Comment No. 322-NFPA 855-2024 [Sections 9.3.1.2, 9.3.1.3]

Sections 9.3.1.2, 9.3.1.3

9.3.1.2

Individual outdoor ESS cabinets ~~that~~ and ESS walk-in units that exceed 53 ft × 8.5 ft × 9.5 ft (16.2 m × 2.6 m × 2.9 m) in size, not including HVAC and other equipment affixed to the unit, shall be treated as indoor installations.

~~**9.3.1.3**~~ ~~*~~ –

~~ESS walk-in units shall be treated as indoor installations.~~

Statement of Problem and Substantiation for Public Comment

This proposal is part of a series of proposals deleting fire suppression requirements targeting walk-in units. The only reason for the walk-in unit sections was to treat them the same as a building for fire protection requirements, primarily fire suppression. The installation of the fire suppression is not practical and is contrary to the requirement that large-scale fire testing document a unit can be consumed by fire and not propagate to other ESS units.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 311-NFPA 855-2024 [Section No. 4.9.1]	
Public Comment No. 316-NFPA 855-2024 [Sections 9.5.3.1.4.1, 9.5.3.1.4.2]	
Public Comment No. 319-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 320-NFPA 855-2024 [Section No. 9.6.2.1]	

Related Item

- CI-185 and FR-46, FR-118

Submitter Information Verification

Submitter Full Name: Robert Davidson
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City:
State:
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Submittal Date: Thu May 30 14:59:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 337-NFPA 855-2024 [Section No. 9.3.2]

9.3.2 Outdoor Installations.

Outdoor ESS installations shall be classified as follows:

(1) *Remote locations*: ESSs located more than 100 ft (30.5 m) from buildings, lot lines that can be built upon, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards- ~~not associated with~~ . Remote ESSs are permitted to be less than 100ft (30.5m) from lot lines and other exposure hazards that are associated with electrical grid infrastructure.

(2) *Locations near exposures*: all outdoor ESS locations that do not comply with remote outdoor location requirements

(3) Specific outdoor locations, as follows:

  (a) *Rooftop installations*: ESS installations located on the roofs of buildings

  (b) *Open parking garage installations*: ESS installations located in a structure or portion of a structure as defined in 3.3.26

  (c) Mobile ESS installations

Statement of Problem and Substantiation for Public Comment

It is common amongst municipalities and AHJ's to have misunderstandings with regards to the term “electrical grid infrastructure” in the Remote definition. We seek to clarify this item so that the relationship is more clear in regards to the ESS and any project-specific substations/related equipment, power lines, and/or adjacent electric utility-owned interconnecting substations and power lines.

Related Item

- PI #257

Submitter Information Verification

Submitter Full Name: Chris Quaranta
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City:
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Submittal Date: Thu May 30 16:22:31 EDT 2024
Committee: ESS-AAA

Public Comment No. 228-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]

ESSs in the following locations shall comply with Section 9.4 as follows:

(1) Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.

(2) Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(3) ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(4) Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries ($ZN-MnO_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium ~~nickel~~ metal chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Statement of Problem and Substantiation for Public Comment

Expands too narrow terminology of sodium nickel chloride and supports disambiguation from other nickel-iron batteries

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL “Current Status of Health and Safety Issues of Sodium/Metal Chloride (Zebra) Batteries” documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Item

- FR-3
- FR-146
- FR-4

Submitter Information Verification

Submitter Full Name: Benjamin Kaun
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Submittal Date: Tue May 28 13:40:48 EDT 2024
Committee: ESS-AAA

Public Comment No. 259-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]

ESSs in the following locations shall comply with Section 9.4 as follows:

(1) Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.

(2) Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(3) ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(4) Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries (ZN-MnO$_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air ~~and Zn~~ batteries	600
Zinc -air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Additional Proposed Changes

File Name	Description	Approved

Table_9.4.1-_NFPA_855_First_Draft_Comments.pdf

Statement of Problem and Substantiation for Public Comment

It is recommended to separate iron-air and zinc-air in Tables 1.3 and 9.4.1. Zinc-air chemistry has the ability to form dendrites and iron-air chemistry is not able to form dendrites. This results in a difference in hazard profiles between the two chemistries, and as a result should not be grouped together.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 258-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name:	Alli Nansel
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Submittal Date:	Wed May 29 14:40:09 EDT 2024
Committee:	ESS-AAA

NFPA 855: First Draft Comments for Iron-Air Updates

The following document outlines Form Energy's submission for the NFPA 855 First Draft comment period. Changes to the current edition are outlined in red.

Table 9.4.1 Maximum Stored Energy

ESS Type	**Maximum Stored Energy (kWh)**
Lead-acid, all types	Unlimited
Nickel batteries	Unlimited
Nickel-hydrogen	Unlimited
Zinc manganese dioxide (Zn-MnO2)	Unlimited
Lithium-ion, all types	600
Lithium metal	600
Zinc bromide	600
Sodium nickel chloride	600
Flow batteries	600
Iron-air ~~and zinc-air~~	600
Zinc-air	600
Other battery technologies	200

Public Comment No. 281-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]

ESSs in the following locations shall comply with Section 9.4 as follows:

(1) Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.

(2) Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(3) ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(4) Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries (ZN-MnO_2)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium ~~nickel~~ metal chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Statement of Problem and Substantiation for Public Comment

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 279-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	FR-3
Public Comment No. 282-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	FR-146
Public Comment No. 279-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	
Public Comment No. 282-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	

Related Item

- FR-4

Submitter Information Verification

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Submittal Date: Thu May 30 08:43:21 EDT 2024

Committee: ESS-AAA

Public Comment No. 309-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]

ESSs in the following locations shall comply with Section 9.4 as follows:

(1) Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.

(2) Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(3) ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(4) Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries ($ZN\text{-}MnO_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Additional Proposed Changes

File Name	Description	Approved
NFPA_855_TG_8_-_Tables_Clean_Up_v1_240520_.pdf		

Statement of Problem and Substantiation for Public Comment

This is a comment to revise the associated table to match the format in previous tables. This proposal aligns the order of the chemistries and technologies across tables 1.3, 9.4.1, and 9.6.6 There are no proposed technical changes. For ease of use, the table in terra-view is not modified. The submitted attachment should be based on the lower table found appropriate for this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 308-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	
Public Comment No. 307-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	
Public Comment No. 307-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]	
Public Comment No. 308-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name: Michael O`Brian

Organization: Code Savvy Consultants

Affiliation: Task Group 8

Street Address:

City:

State:

Zip:

Submittal Date: Thu May 30 13:53:23 EDT 2024

Committee: ESS-AAA

NFPA 855, Task Group 8, New Technologies - Updated Tables 1.3, 9.4.1 and 9.6.6

Version 1, May 20, 2024 (A. Skoskiewicz)

1) Standardized the technology language used in all 3 tables
2) Alphabetized the tables, with "Other" being last
3) Switched to proper footnote callouts (a, b, c), instead of (*, +) and re-arranged sequence
4) Introduced metric conversion to Table 9.4.1 (similar to Table 1.3)
5) Original Screenshots presented first (row 15+), followed by proposed table (row 50+), followed by "Original Table, digital" (row 80+)
6) Proposed Tables have strikethroughs (deleted text) and underlines (added text). No markings for moved text.
7) Added footnotes "b" and "c" to Table 9.6.6 for consistency
8) Added "Reference Line" as part of the Table 9.6.6 Header.
9) Created a single "Other" bucket to lower ambiguity.

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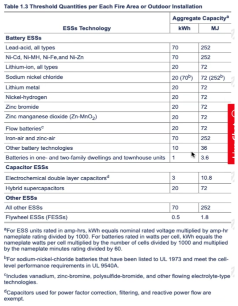

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO$_2$)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

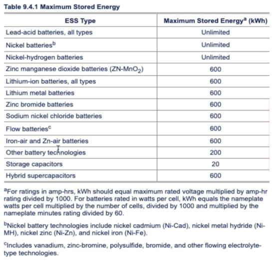

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries (ZN-MnO$_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

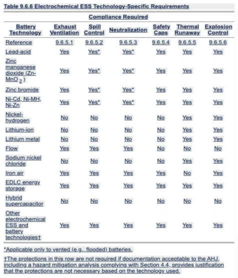

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES

PROPOSED - Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation

	ESS Technology Type	Aggregate Capacity[a]	
		kWh	MJ
1	Batteries in one- and two-family dwellings and townhouse units	1	3.6
2	Electrochemical double layer capacitors (EDLC)[b]	3	10.8
3	Flow batteries[c]	20	72
4	Flywheel ESSs (FESSs)	0.5	1.8
5	Hybrid supercapacitors	20	72
6	Iron-air and zinc-air	70	252
7	Lead-acid, all types	70	252
8	Lithium-ion, all types	20	72
9	Lithium metal	20	72
10	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
11	Nickel-hydrogen	20	72
12	Sodium nickel chloride	20 (70)[d]	72 (252)[d]
13	Zinc bromide	20	72
14	Zinc manganese dioxide (Zn-MnO$_2$)	20	72
15	All other ESSs technologies	10	36

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

PROPOSED - Table 9.4.1 Maximum Stored Energy

	ESS Technology Type	Maximum Stored Energy[a] (kWh)	
		kWh	MJ
1	Electrochemical double layer capacitors (EDLC)[b] ~~Storage capacitors~~	20	72
2	Flow batteries[c]	600	2160
3	Hybrid supercapacitors	600	2160
4	Iron-air and ~~Zn~~ zinc-air batteries	600	2160
5	Lead-acid ~~batteries~~, all types	Unlimited	Unlimited
6	Lithium-ion ~~batteries~~, all types	600	2160
7	Lithium metal ~~batteries~~	600	2160
8	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn ~~Nickel batteries~~[d]	Unlimited	Unlimited
9	Nickel-hydrogen ~~batteries~~	Unlimited	Unlimited
10	Sodium nickel chloride ~~batteries~~	600	2160
11	Zinc bromide	600	2160
12	Zinc manganese dioxide batteries (Zn-MnO$_2$)	600	2160
13	All other ESS ~~battery~~ technologies	200	720

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

~~[d] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)~~

PROPOSED - Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	~~Battery Technology~~ ESS Technology Type	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
	Reference	**9.6.5.1**	**9.6.5.2**	**9.6.5.3**	**9.6.5.4**	**9.6.5.5**	**9.6.5.6**
1	Electrochemical double layer capacitors (EDLC)[b] ~~energy storage~~	Yes	Yes	Yes	Yes	Yes	Yes
2	Flow batteries[c]	Yes	Yes	Yes	No	No	No
3	Hybrid supercapacitors	No	No	No	No	No	No
4	Iron air and zinc-air	Yes	Yes	Yes	Yes	No	Yes
5	Lead-acid, all types	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
6	Lithium-ion, all types	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Ni-Cd, Ni-MH, Ni-Fe, and Ni-Zn	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
9	Nickel-hydrogen	No	No	No	No	Yes	Yes
10	Sodium nickel chloride	No	No	No	No	Yes	Yes
11	Zinc bromide	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
12	Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
13	All other ~~electrochemical~~ ESS ~~and battery~~ techologies[b]	Yes	Yes	Yes	Yes	Yes	Yes

[a] Applicable only to vented (e.g. flooded) batteries

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[b] The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES

Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation (as written)

	ESS Technology	Aggregate Capacity[a]	
		kWh	MJ
	Battery ESS		
1	Lead-acid, all types	70	252
2	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
3	Lithium-ion, all types	20	72
4	Sodium nickel chloride	20 (70[b])	72 (252[b])
5	Lithium metal	20	72
6	Nickel-hydrogen	20	72
7	Zinc bromide	20	72
8	Zinc manganese dioxide (Zn-MnO$_2$)	20	72
9	Flow batteries[c]	20	72
10	Iron-air and zinc-air	70	252
11	Other battery technologies	10	36
12	Batteries in one- and two-family dwellings and townhouse units	1	3.6
	Capacitor ESSs		
13	Electrochemical double layer capacitors[d]	3	10.8
14	Hybrid supercapacitors	20	72
	Other ESSs		
15	All other ESSs	70	252
16	Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Table 9.4.1 Maximum Stored Energy

	ESS Type	Maximum Stored Energy[a] (kWh)
1	Lead-acid batteries, all types	Unlimited
2	Nickel batteries[b]	Unlimited
3	Nickel-hydrogen batteries	Unlimited
4	Zinc manganese dioxide batteries (Zn-MnO$_2$)	600
5	Lithium-ion batteries, all types	600
6	Lithium metal batteries	600
7	Zinc bromide batteries	600
8	Sodium nickel chloride batteries	600
9	Flow batteries[c]	600
10	Iron-air and Zn-air batteries	600
11	Other battery technologies	200
12	Storage capacitors	20
13	Hybrid supercapacitors	600

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

		Compliance Required					
	Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
	Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
1	Lead-acid	Yes	Yes *	Yes *	Yes	Yes	Yes
2	Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes *	Yes *	Yes	Yes	Yes
3	Zing bromide	Yes	Yes *	Yes *	Yes	Yes	Yes
4	Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes *	Yes *	Yes	Yes	Yes
5	Nickel Hydrogen	No	No	No	No	Yes	Yes
6	Lithium-ion	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Flow	Yes	Yes	Yes	No	No	No
9	Sodium nickel chloride	No	No	No	No	Yes	Yes
10	Iron air	Yes	Yes	Yes	Yes	No	Yes
11	EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
12	Hybrid supercapacitor	No	No	No	No	No	No
13	Other electrochemical ESS and battery techologies +	Yes	Yes	Yes	Yes	Yes	Yes

* Applicable only to vented (e.g. flooded) batteries

+ The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

END END END END END END END END

Public Comment No. 90-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]

ESSs in the following locations shall comply with Section 9.4 as follows:

(1) Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1.

(2) Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(3) ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

(4) Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2.

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries ($ZN\text{-}MnO_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Sodium sulfur	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a] For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

Statement of Problem and Substantiation for Public Comment

In addition to the comment made for Table 1.3 in Chapter 1, we would like to indicate that the maximum energy that can be stored in the system is 1450 kWh (energy capacity of one NAS® battery container). In the table, a value of 600 kWh for the maximum stored energy of sodium sulfur batteries is appropriate as this is similar to the capacity of other recognized technologies (in particular sodium nickel chloride batteries).

The necessary documents can be found at the link: https://web.tresorit.com/l/SonJ0#lRHsZkJsbEu-m16bSfnEow

Related Item

- FR-4

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]

Sections 9.4.1, 9.4.2

9.4.

~~1 Maximum Stored Energy. ESSs in the following locations shall comply with Section 9.4 as follows:~~

- ~~Fire areas within non-dedicated-use buildings containing ESSs shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.1 .~~

~~Outdoor ESS installations in locations near exposures shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.~~

2

~~.~~

- ~~ESS installations in open parking garages and on rooftops of buildings shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2 .~~
- ~~Mobile ESS equipment as covered by 9.5.3.2 shall not exceed the maximum stored energy values in Table 9.4.1 except as permitted by 9.4.1.2 .~~

~~Table 9.4.1 Maximum Stored Energy~~

~~ESS Type Maximum Stored Energy~~ [a] ~~(kWh) Lead-acid batteries, all types Unlimited Nickel batteries~~ [b] ~~Unlimited Nickel-hydrogen batteries Unlimited Zinc manganese dioxide batteries (ZN-MnO~~$_2$ ~~) 600 Lithium-ion batteries, all types 600 Lithium metal batteries 600 Zinc bromide batteries 600 Sodium nickel chloride batteries 600 Flow batteries~~ [c] ~~600 Iron-air and Zn-air batteries 600 Other battery technologies 200 Storage capacitors 20 Hybrid supercapacitors 600~~

[a] ~~For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.~~

[b] ~~Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).~~

[c] ~~Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.~~

~~9.4.1.1~~ –

~~Where approved by the AHJ, fire areas in non-dedicated-use buildings containing ESSs that exceed the amounts in Table 9.4.1 shall be permitted based on a hazard mitigation analysis in accordance with Section 4.4 and fire and explosion testing complying with 9.1.5 .~~

~~9.4.1.2~~ –

~~Where approved by the AHJ, outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment that exceed the amounts in Table 9.4.1 shall be permitted based on a hazard mitigation analysis in accordance with Section 4.4 and fire and explosion testing in accordance with 9.1.5 .~~

~~9.4.1.3~~ –

~~Where a single fire area within a building or walk-in unit contains a combination of energy systems covered in Table 9.4.1 , the maximum stored energy per fire area shall be determined based on the sum of percentages of each type divided by the maximum stored energy of each type.~~

~~9.4.1.4~~ –

~~The sum of the percentages calculated in 9.4.1.3 shall not exceed 100 percent except as permitted in 9.4.1.1 or 9.6.2.3 .~~

~~9.4.2~~

* _ Size and Separation.

9.4.2.1 _

ESSs shall be comprised of groups with a maximum stored energy of

~~50 kWh~~

20 kWh each.

9.4.2.2 _

Each group shall be spaced a minimum 3 ft (0.9 m) from other groups and from walls in the storage room or area.

9.4.2.3 _

The AHJ shall be permitted to approve groups with larger energy capacities or smaller group spacing based on performance criteria from fire and explosion testing complying with 9.1.5 .

9.4.2.4 _ Lead-Acid and Nickel-Cadmium Battery Systems.

9.4.2.4.1 * _

Lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less, shall not be required to comply with 9.4.2.1 through 9.4.2.3 .

9.4.2.4.2 _

Paragraphs 9.4.2.1 and 9.4.2.2 shall not apply to lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778, utilized for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located.

Statement of Problem and Substantiation for Public Comment

This proposal is from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

This proposal and related proposals delete the MAQ language and the size and separation trigger is lowered from 50 kWh to 20 kWh.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	
Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]	
Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]	

Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]

Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]

Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]

Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]

Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]

Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]

Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]

Related Item

- FR-4

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 50-NFPA 855-2024 [Section No. 9.4.2]

9.4.2* Size and Separation.

9.4.2.1

ESSs shall be comprised of groups with a maximum stored energy of 50 kWh each.

9.4.2.2

Each group shall be spaced a minimum 3 ft (0.9 m) from other groups and from walls in the storage room or area.

9.4.2.3

The AHJ shall be permitted to approve groups with larger energy capacities or smaller group spacing based on performance criteria from fire and explosion testing complying with 9.1.5.

9.4.2.4 Lead-Acid and Nickel-Cadmium Battery Systems.

9.4.2.4.1* –

~~Lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less, shall not be required to comply with~~

-

The requirements in 9.4.2 ~~.1 through~~ ~~9.4.2.3~~ ~~.~~ shall not apply to traditional standby power applications.

9.4.2.4.2

~~Paragraphs~~ The requirements in 9.4.2 ~~.1 and~~ ~~9.4.2.2~~ - shall not apply to lead-acid ~~battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778, utilized for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located~~ and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less .

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-128

Submitter Information Verification

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Submittal Date: Fri Mar 15 09:30:03 EDT 2024

Committee: ESS-AAA

Public Comment No. 162-NFPA 855-2024 [Section No. 9.4.2.4]

9.4.2.4 Lead-Acid and Nickel-Cadmium Battery Systems.

9.4.2.4.1*

~~Lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less, shall not be required to comply with~~
The requirements of 9.4.2.1 through 9.4.2.3

~~.~~

~~**9.4.2.4.2**~~ –

~~Paragraphs 9.4.2.1 and 9.4.2.2~~
shall not apply to lead-acid

~~battery systems in uninterruptable power supplies listed and labeled in accordance with UL 1778, utilized for standby power applications, which is limited to not more than 10 percent~~
and nickel-cadmium batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(6) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which

~~the ESS is~~

(1) they are located.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggest simplifications are welcomed.

Related Item

- TG 24

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Committee: ESS-AAA

Public Comment No. 75-NFPA 855-2024 [New Section after 9.5]

Commentary on CI-104 and CI-105

Statement of Problem and Substantiation for Public Comment

I suggest putting this content in the annex for now till we better understand the risk relative to other plastic fires and EV fires.

Related Item

- CI-104 and CI-105

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Public Comment No. 238-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]

Indoor ESS installations shall comply with this section and as detailed in Table 9.5.1.

Table 9.5.1 Indoor ESS Installations

Compliance Required	ESS Dedicated-Use Buildings	Non-Dedicated-Use Buildings	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Size and separation	Yes	Yes	9.4.2
Maximum stored energy	No	Yes	9.4.1
Elevation	Yes	Yes	4.7.7
Fire barriers	NA	Yes	9.6.4
Smoke and fire detection	Yes	Yes	9.6.1
Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Yes	9.5.1.2.1
Technology-specific protection	Yes	Yes	9.6.5

NA: Not applicable.

Statement of Problem and Substantiation for Public Comment

Committee input on toxic CI 104, requested input on adding Toxics to the tables. TG 6 has provided guidance to Toxics and first responders in the Annex. As such no new toxic section has been add and modifications to the tables are not required.

Related Item

- CI 104

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Committee: ESS-AAA

Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]

Indoor ESS installations shall comply with this section and as detailed in Table 9.5.1.

Table 9.5.1 Indoor ESS Installations

Compliance Required	ESS Dedicated-Use Buildings	Non-Dedicated-Use Buildings	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Size and separation	Yes	Yes	9.4.2
~~Maximum stored energy~~	~~No~~	~~Yes~~	~~9.4.1~~
Elevation	Yes	Yes	4.7.7
Fire barriers	NA	Yes	9.6.4
Smoke and fire detection	Yes	Yes	9.6.1
Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Yes	9.5.1.2.1
Technology-specific protection	Yes	Yes	9.6.5

NA: Not applicable.

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	Series of proposals deleing related content on MAQ
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	

Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]

Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]

Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]

Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name:	Robert Davidson
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Submittal Date:	Thu May 30 12:58:27 EDT 2024
Committee:	ESS-AAA

Public Comment No. 239-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]

Outdoor ESS installations shall comply with this section and as detailed in Table 9.5.2.

Table 9.5.2 Outdoor Stationary ESS Installations

Compliance Required	Remote Locations	Locations Near Exposures	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Clearance to exposures	NA	Yes	9.5.2.6.1
Means of egress separation	NA	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Vegetation control	Yes	Yes	9.5.2.2
Enclosures	Yes	Yes	4.6.12
Size and separation	No	Yes	9.4.2
Maximum stored energy	No	Yes	9.4.1
Smoke and fire detection	Yes	Yes	9.6.1
Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Technology-specific protection	Yes	Yes	9.6.5

NA: Not applicable.

Statement of Problem and Substantiation for Public Comment

Committee input on toxic CI 104, requested input on adding Toxics to the tables. TG 6 has provided guidance to Toxics and first responders in the Annex. As such no new toxic section has been add and modifications to the tables are not required.

Related Item

- CI 105

Submitter Information Verification

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Submittal Date: Wed May 29 09:48:14 EDT 2024
Committee: ESS-AAA

Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]

Outdoor ESS installations shall comply with this section and as detailed in Table 9.5.2.

Table 9.5.2 Outdoor Stationary ESS Installations

Compliance Required	Remote Locations	Locations Near Exposures	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Clearance to exposures	NA	Yes	9.5.2.6.1
Means of egress separation	NA	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Vegetation control	Yes	Yes	9.5.2.2
Enclosures	Yes	Yes	4.6.12
Size and separation	No	Yes	9.4.2
~~Maximum stored energy~~	~~No~~	~~Yes~~	~~9.4.1~~
Smoke and fire detection	Yes	Yes	9.6.1
Fire control and suppression	Yes	Yes	9.6.2
Water supply	Yes	Yes	9.6.3
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Technology-specific protection	Yes	Yes	9.6.5

NA: Not applicable.

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	

Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]

Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]

Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]

Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name: Robert Davidson
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Submittal Date: Thu May 30 13:06:13 EDT 2024
Committee: ESS-AAA

Public Comment No. 25-NFPA 855-2024 [Section No. 9.5.2.1]

~~**9.5.2.1** – HMA.~~

~~An HMA shall be required for lithium-ion ESSs that exceed 600 kWh (2,160 MJ) for outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment.~~

Statement of Problem and Substantiation for Public Comment

This requirement is already covered by section 9.4.1.2 in Maximum Stored Energy. Section 9.4.1.2 already dictates that an HMA is needed when any lithium ion installations exceed 600 kWh. This text, specific for outdoor installations, is redundant and can be deleted from this part of the standard.

Related Item

- PI-308

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Submittal Date:	Wed Mar 13 11:34:43 EDT 2024
Committee:	ESS-AAA

Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]

9.5.2.1 HMA.

An HMA shall be required for lithium-ion ~~ESSs that exceed 600 kWh (2,160 MJ) for~~ ESSs for outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment.

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]	
Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]	

Related Item

- FR-4

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Committee: ESS-AAA

Public Comment No. 26-NFPA 855-2024 [Section No. 9.5.2.3]

9. ~~5~~ **4** **.2.3** – _ Walk-in Units.

Spacing shall not be required between the ESS and the enclosure walls in outdoor walk-in unit installations.

Statement of Problem and Substantiation for Public Comment

Section 9.4.2 requires 3 ft spacing from walls for indoor installations, including dedicated use buildings. We indicate in other places that outdoor walk-in units are considered indoor installations but hidden here (in outdoor section) we exempt walk-in units from the spacing rule. Consider moving this exemption text to the spacing section 9.4.2. so it can be properly applied.

Related Item

- FR-119

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Wed Mar 13 12:03:19 EDT 2024
Committee: ESS-AAA

Public Comment No. 27-NFPA 855-2024 [Section No. 9.5.2.4]

9.5.2.4 Maximum Size.

9.5.2.4.1

~~Outdoor ESS walk-in units or ESS~~ Individual outdoor ESS cabinets shall not exceed 53 ft × 8.5 ft × 9.5 ft (16.2 m × 2.6 m × 2.9 m), not including HVAC and other equipment. affixed to the unit.

9.5.2.4.2

~~Outdoor~~ ESS ~~walk-in units or ESS~~ cabinets that exceed the dimensions in 9.5.2.4.1 shall be treated as indoor installations and comply with the requirements in 9.5.1.

Statement of Problem and Substantiation for Public Comment

Making wording consistent with changes provided in 9.3.1.2.

Related Item

- PI-282

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Wed Mar 13 12:13:39 EDT 2024
Committee: ESS-AAA

Public Comment No. 342-NFPA 855-2024 [Section No. 9.5.2.4.1]

9.5.2.4.1

Outdoor ESS ~~walk-in units or ESS cabinets~~ shall not exceed 53 ft × 8.5 ft × 9.5 ft (16.2 m × 2.6 m × 2.9 m) or 4279.75 cubic feet(122.2 cubic meters) , not including HVAC and other equipment.

Statement of Problem and Substantiation for Public Comment

Size limitation was based on previous generation ESS that utilized modified shipping containers that have set max length, widths, and height. Custom purpose built ESS should not be subject to width and height restrictions based on ISO container sizing. Changed to include volumentric calculation that would allow a shorter ESS but one that may be wider or taller.

Related Item

- Public Input No. 258-NFPA 855-2023
- Public Input No. 103-NFPA 855-2023
- Public Input No. 282-NFPA 855-2023

Submitter Information Verification

Submitter Full Name: Chris Groves
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Submittal Date: Thu May 30 16:45:36 EDT 2024
Committee: ESS-AAA

Public Comment No. 28-NFPA 855-2024 [Section No. 9.5.2.6.1.8(A)]

(A)

ESSs shall be permitted to be installed outdoors on exterior walls of buildings when all of the following conditions are met:

(1) The maximum stored energy of individual ESS units shall not exceed 20 kWh (72 MJ).

(2) ~~The ESS shall comply with applicable requirements in Chapter 4 .~~

(3) ~~The ESS shall be installed in accordance with the manufacturer's instructions and their listing.~~

(4) Individual ESS units shall be separated from each other by at least 3 ft (0.9 m).

(5) The ESS shall be separated from doors, windows, operable openings into buildings, or HVAC inlets by at least 5 ft (1.5 m).

Statement of Problem and Substantiation for Public Comment

The change removes text that is well covered elsewhere and focuses only on those requirements unique to exterior wall installations which should be emphasized.

Related Item

- PI-319

Submitter Information Verification

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Submittal Date: Wed Mar 13 12:50:03 EDT 2024
Committee: ESS-AAA

Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]

Rooftop and open parking garage ESS installations shall comply with this section and as detailed in Table 9.5.3.1.

Table 9.5.3.1 Rooftop and Open Parking Garage ESS Installations

Compliance Required	Rooftops	Open Parking Garages	Reference
Administrative	Yes	Yes	Chapters 1–3
General	Yes	Yes	Sections 4.1–4.7
Maximum size	Yes	Yes	9.5.2.4
Means of egress separation	Yes	Yes	9.5.2.6.1.7
Walk-in units	Yes	Yes	9.5.2.3
Enclosures	Yes	Yes	4.6.12
Clearance to exposures	Yes	Yes	9.5.3.1.3
Fire suppression and control	Yes	Yes	9.5.3.1.4
-	-	-	-
-	-	-	-
Size and separation	Yes	Yes	9.4.2
~~Maximum stored energy~~	~~Yes~~	~~Yes~~	~~9.4.1~~
Elevation	Yes	Yes	4.7.7
Smoke and fire detection	Yes	Yes	9.6.1
Signage	Yes	Yes	4.7.4
Occupied work centers	Not allowed	Not allowed	9.5.1.2.1
Open rack installations	Not allowed	Not allowed	4.7.9
Exhaust ventilation during normal operations*	Yes	Yes	9.6.5.1
Spill control*	Yes	Yes	9.6.5.2
Neutralization*	Yes	Yes	9.6.5.3
Safety caps*	Yes	Yes	9.6.5.4
Thermal runaway*	Yes	Yes	9.6.5.5
Explosion control*	Yes	Yes	9.6.5.6

NA: Not applicable.

*Table 9.6.5 determines if a subcategory of electrochemical ESSs must comply with this requirement. The listed reference section determines whether the requirement applies to the form-factor of the ESS.

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]	

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name: Robert Davidson
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Submittal Date: Thu May 30 13:14:35 EDT 2024
Committee: ESS-AAA

Public Comment No. 355-NFPA 855-2024 [Sections 9.5.3.1.1.2, 9.5.3.1.1.3]

Sections 9.5.3.1.1.2, 9.5.3.1.1.3

9.5.3.1.1.2

ESSs comprised of units with a maximum stored energy greater than 20 kWh, and associated equipment, that are located on rooftops and not enclosed by building construction shall comply with the following:

(1) The roofing materials under and within 5 ft (1.5 m) horizontally from an ESS or associated equipment shall comply with one of the following:

  (a) Be noncombustible

  (b) Have a Class A rating when tested in accordance with ASTM E108 or UL 790

(2) ESSs and associated equipment shall be located from the edge of the roof a distance equal to at least the height of the system, equipment, or component but not less than 5 ft (1.5 m).

(3) Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted where approved by the AHJ.

(4) The ESS shall be a minimum of 10 ft (3 m) from the fire service access point on the rooftop.

(5) Stairway access to the roof for emergency response and fire department personnel shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building.

(6) Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes.

(7) Service walkways at least 5 ft (1.5 m) in width shall be provided for service and emergency personnel from the point of access to the roof to the system.

(8) A Class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level.

(9) A thermal image fire detection system or radiant-energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS.

9.5.3.1.1.3

Individual ESS units with a maximum stored energy of 20 kWh or less that are located on rooftops shall comply with all of the following:

(1) The systems shall be listed in accordance with 4.6.1.

(2) The systems shall comply with 9.5.3.1.1.2(1) through 9.5.3.1.1.2(4).

(3)* The systems shall comply with the fire and explosion testing requirements in its intended installation configuration.

(4) The ESS unit shall meet the unit level fire performance requirements of indoor residential units as identified in UL 9540A.

(5) Each ESS unit shall be spaced a minimum of 3 ft (0.9 m) from other units, except as provided in 9.5.3.1.1.3(6).

(6) The AHJ shall be permitted to approve a smaller distance based on performance criteria from fire and explosion testing complying with 9.1.5.

Additional Proposed Changes

File Name	Description	Approved
TIA_855_23_2_1746.pdf	855_23_2_1746	

Statement of Problem and Substantiation for Public Comment

NOTE: This public input originates from Tentative Interim Amendment No. 23-1 (Log No. 1746) issued by the Standards Council on August 25, 2023 and per the NFPA Regs., needs to be reconsidered by the Technical Committee for the next edition of the Document.

Substantiation: These changes correct the inadvertent omission of guidance in the Standard to address new technologies in outdoor rooftop installations such as ESS integrated with rooftop PV arrays, or other rooftop distributed small ESS. This omission was due to industry innovation that would seek to install small ESS on rooftops.
The changes to 9.5.3.1.1.2 Rooftop Requirements clarify the list pertains to larger ESS cabinets and walk-in enclosures. The addition of a new section 9.5.3.1.1.3 clarifies requirements for small individual ESS that meet the performance requirements of indoor residential systems which are intended to be located on commercial rooftops.
These requirements include:
(1) listing,
(2) Class A roofing, setback from roof edge, elevation limit, and rooftop access point (bulkhead opening).
(3) Clarifies that testing must be in the designed orientation to address unique installation locations such as under a PV array with additional annex material.
(4) Requires testing to UL9540A with no external fire at the unit level as determined in the residential wall mounted test with cheesecloth.
(5) Clarifies size & separation requirements are applicable in ESS <20kWh in rooftop installations.
(6) Allows closer spacing based on results of UL9540A fire testing.
This TIA was submitted by the NFPA 855 Rooftop Task Group.

Emergency Nature: The standard contains an error or an omission that was overlooked during the regular revision process. The proposed TIA intends to correct a circumstance in which the revised NFPA Standard has resulted in an adverse impact on a product or method that was inadvertently overlooked in the total revision process or was without adequate technical (safety) justification for the action.
Technological advancements have resulted in small ESS that meet the strictest fire safety performance to be allowed inside 1 & 2 family dwellings. These small ESS <20kWh are being designed to be installed on rooftops and integrated into PV arrays. To support outdoor installations on commercial rooftops, this section of the Standard must be corrected to consider the size & separation limits, as well as the higher fire safety performance requirements for small ESS.

Related Item

- Tentative Interim Amendment No. 1746

Submitter Information Verification

Submitter Full Name:	NFPA TIA
Organization:	Technical Committee on Energy Storage Systems
Street Address:	
City:	
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Zip:	
Submittal Date:	Tue Jun 04 16:41:25 EDT 2024
Committee:	ESS-AAA

Tentative Interim Amendment

NFPA® 855

Standard for the Installation of Stationary Energy Storage Systems

2023 Edition

Reference: 9.5.3.1.1.2, 9.5.3.1.1.3(new), and A.9.5.3.1.1.3(3)(new)
TIA 23-2
(SC 23-8-65 / TIA Log #1746)

Pursuant to Section 5 of the NFPA *Regulations Governing the Development of NFPA Standards*, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, 2023 edition. The TIA was processed by the Technical Committee on Energy Storage Systems, and was issued by the Standards Council on August 25, 2023, with an effective date of September 14, 2023.

1. Revise paragraph 9.5.3.1.1.2 to read as follows:

9.5.3.1.1 Rooftop Installations.

9.5.3.1.1.1 Installations shall be permitted on rooftops of buildings that do not obstruct fire department rooftop operations when approved.

9.5.3.1.1.2 ESS comprised of units with a maximum stored energy greater than 20 kWh, and associated equipment, that are located on rooftops and not enclosed by building construction shall comply with the following:

(1~~4~~) The roofing materials under and within 5 ft (1.5 m) horizontally from an ESS or associated equipment shall ~~be~~ comply with one of the following:
(a) Be noncombustible
(b) ~~or shall have~~ Have a Class A rating when tested in accordance with ASTM E108 or UL 790~~.~~
(2~~3~~) ESS and associated equipment shall be located from the edge of the roof a distance equal to at least the height of the system, equipment, or component but not less than 5 ft (1.5 m).
(3~~6~~) Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted ~~when~~ where approved by the AHJ.
(4~~9~~) The ESS shall be a minimum of 10 ft (3 m) from the fire service access point on the rooftop.
(5~~1~~) Stairway access to the roof for emergency response and fire department personnel shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building.
(6~~7~~) Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes.
(7~~2~~) Service walkways at least 5 ft (1.5 m) in width shall be provided for service and emergency personnel from the point of access to the roof to the system.
(8~~5~~) A Class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level.
(9~~8~~) A ~~radiant~~ radiant-energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS.

2. Add new section 9.5.3.1.1.3 and associated Annex text to read as follows:

9.5.3.1.1.3 Individual ESS units with a maximum stored energy of 20 kWh or less that are located on rooftops shall comply with all of the following:
(1) The systems shall be listed in accordance with 4.6.1.
(2) The systems shall comply with 9.5.3.1.1.2(1) through 9.5.3.1.1.2(4).
(3)* The systems shall comply with the fire and explosion testing requirements in its intended installation configuration.

(4) The ESS unit shall meet the unit level fire performance requirements of indoor residential units as identified in UL 9540A.
(5) Each ESS unit shall be spaced a minimum of 3 ft (0.9m) from other units, except as provided in 9.5.3.1.1.3 (6).
(6) The AHJ shall be permitted to approve a smaller distance based on performance criteria from fire and explosion testing complying with 9.1.5.

A.9.5.3.1.1.3(3) This item addresses concerns related to radiant energy on nearby flammable components such as batteries under a PV array. UL 9540A fire testing should be done on a representative installation configuration. Other siting considerations include minimum distances, installation instructions, or relevant safety standards that might address this new application of ESS such as UL 2703, which covers the fire rating of the PV system (i.e., PV modules, racking, and roofing) and might need to consider the effect of additional components in the testing.

Issue Date: August 25, 2023

Effective Date: September 14, 2023

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/docinfo)

Public Comment No. 81-NFPA 855-2024 [Section No. 9.5.3.1.4]

9.5.3.1.4 Fire Control, Suppression, and ~~Control.~~ Thermal Runaway Protection

9.5.3.1.4.1

ESSs located in walk-in enclosures on rooftops or in open parking garages shall be provided with automatic fire control and suppression ~~systems within~~ system or Thermal Runaway Protection System within the ESS enclosure in accordance with Section 4.9.

9.5.3.1.4.2

Areas containing ESSs other than walk-in units in open parking structures not open above to the sky shall be provided with an automatic fire suppression ~~system~~ or Thermal Runaway Protection system complying with Section 4.9.

9.5.3.1.4.3

When approved by the AHJ, ESSs shall be permitted to be installed in open parking garages without the protection of an automatic fire control and suppression system where fire and explosion testing conducted in accordance with 9.1.5 indicates that an ESS fire does not present an exposure hazard to parked vehicles or compromise the means of egress.

Statement of Problem and Substantiation for Public Comment

This text recognizes thermal runaway management systems and their use in ESS.

Related Item

- FR-45

Submitter Information Verification

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Submittal Date: Tue Apr 02 13:54:55 EDT 2024
Committee: ESS-AAA

Public Comment No. 316-NFPA 855-2024 [Sections 9.5.3.1.4.1, 9.5.3.1.4.2]

Sections 9.5.3.1.4.1, 9.5.3.1.4.2

9.5.3.1.4.1

ESSs ~~located in walk-in enclosures on rooftops or in~~ located in open parking garages shall be provided with automatic fire control and suppression systems within the ESS enclosure in accordance with Section 4.9.

9.5.3.1.4.2

Areas containing ~~ESSs other than walk-in units in open parking structures not open~~ ESSs not open above to the sky shall be provided with an automatic fire suppression system complying with Section 4.9.

Statement of Problem and Substantiation for Public Comment

This proposal is part of a series of proposals deleting fire suppression requirements targeting walk-in units. The only reason for the walk-in unit sections was to treat them the same as a building for fire protection requirements, primarily fire suppression. The installation of the fire suppression is not practical and is contrary to the requirement that large-scale fire testing document a unit can be consumed by fire and not propagate to other ESS units.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 311-NFPA 855-2024 [Section No. 4.9.1]	
Public Comment No. 319-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 320-NFPA 855-2024 [Section No. 9.6.2.1]	
Public Comment No. 322-NFPA 855-2024 [Sections 9.3.1.2, 9.3.1.3]	

Related Item

• CI-185 • FR-46

Submitter Information Verification

Submitter Full Name: Robert Davidson
Organization: Davidson Code Concepts, LLC
Street Address:
City:
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Submittal Date: Thu May 30 14:36:19 EDT 2024
Committee: ESS-AAA

Public Comment No. 191-NFPA 855-2024 [Section No. 9.5.3.1.4.2]

9.5.3.1.4.2*

Areas containing ESSs other than walk-in units in open parking structures not open above to the sky shall be provided with an automatic fire suppression system complying with Section 4.9.

A.9.5.3.1.4.2 Per Annex A4.9.1 -T his section is meant to be applied to exposure and not internal to enclosures or cabinets.

Statement of Problem and Substantiation for Public Comment

Added to provide additional clarity to expected coverage area.

Related Item

- FR 45

Submitter Information Verification

Submitter Full Name: Paul Hayes
Organization: The Hiller Companies/American
Street Address:
City:
State:
Zip:
Submittal Date: Mon May 27 12:34:51 EDT 2024
Committee: ESS-AAA

Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Deployed mobile ESS equipment and operations shall comply with this section and Table 9.5.3.2.7.

Table 9.5.3.2.7 Mobile Energy Storage Systems (ESSs)

Compliance Required	Deployment	Reference
Administrative	Yes	Chapters 1–3
General	Yes	Sections 4.1–4.7
Size and separation	Yes[a]	9.4.2
~~Maximum stored energy~~	~~Yes~~	~~9.4.1~~
Fire and smoke detection	Yes[b]	9.6.1
Fire control and suppression	Yes[c]	9.6.2
Maximum size	Yes	9.5.2.4
Vegetation control	Yes	9.5.2.2
Means of egress separation	Yes	9.5.2.6.1.7
Exhaust ventilation during normal operations[d]	Yes	9.6.5.1
Spill control[d]	Yes	9.6.5.2
Neutralization[d]	Yes	9.6.5.3
Safety caps[d]	Yes	9.6.5.4
Thermal runaway[d]	Yes	9.6.5.5
Explosion control[d]	Yes	9.6.5.6

[a] In walk-in units, spacing is not required between ESS units and the walls of the enclosure.

[b] Alarm signals are not required to be transmitted to an approved location for mobile ESSs deployed 30 days or less.

[c] Only required for walk-in units.

[d] Table 9.6.5 determines if a subcategory of electrochemical ESSs must comply with this requirement. The listed reference section determines whether the requirement applies to the form-factor of the ESS.

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	
Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]	

Related Item

• FR-4 •

Submitter Information Verification

Submitter Full Name:	Robert Davidson
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Submittal Date:	Thu May 30 13:18:17 EDT 2024
Committee:	ESS-AAA

Public Comment No. 319-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Deployed mobile ESS equipment and operations shall comply with this section and Table 9.5.3.2.7.

Table 9.5.3.2.7 Mobile Energy Storage Systems (ESSs)

Compliance Required	Deployment	Reference
Administrative	Yes	Chapters 1–3
General	Yes	Sections 4.1–4.7
Size and separation	Yes[a]	9.4.2
Maximum stored energy	Yes	9.4.1
Fire and smoke detection	Yes[b]	9.6.1
~~Fire control and suppression~~	~~Yes~~ [e]	~~9.6.2~~
Maximum size	Yes	9.5.2.4
Vegetation control	Yes	9.5.2.2
Means of egress separation	Yes	9.5.2.6.1.7
Exhaust ventilation during normal operations[d]	Yes	9.6.5.1
Spill control[d]	Yes	9.6.5.2
Neutralization[d]	Yes	9.6.5.3
Safety caps[d]	Yes	9.6.5.4
Thermal runaway[d]	Yes	9.6.5.5
Explosion control[d]	Yes	9.6.5.6

[a] In walk-in units, spacing is not required between ESS units and the walls of the enclosure.

[b] Alarm signals are not required to be transmitted to an approved location for mobile ESSs deployed 30 days or less.

[e] ~~Only required for walk-in units.~~

[d] Table 9.6.5 determines if a subcategory of electrochemical ESSs must comply with this requirement. The listed reference section determines whether the requirement applies to the form-factor of the ESS.

Statement of Problem and Substantiation for Public Comment

This proposal is part of a series of proposals deleting fire suppression requirements targeting walk-in units. The only reason for the walk-in unit sections was to treat them the same as a building for fire protection requirements, primarily fire suppression. The installation of the fire suppression is not practical and is contrary to the requirement that large-scale fire testing document a unit can be consumed by fire and not propagate to other ESS units.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 311-NFPA 855-2024 [Section No. 4.9.1]	Content connected
Public Comment No. 316-NFPA 855-2024 [Sections 9.5.3.1.4.1, 9.5.3.1.4.2]	Content connected
Public Comment No. 320-NFPA 855-2024 [Section No. 9.6.2.1]	
Public Comment No. 322-NFPA 855-2024 [Sections 9.3.1.2, 9.3.1.3]	

Related Item

- CI-185
- FR-46

Submitter Information Verification

Submitter Full Name:	Robert Davidson
Organization:	Davidson Code Concepts, LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu May 30 14:43:51 EDT 2024
Committee:	ESS-AAA

Public Comment No. 51-NFPA 855-2024 [Sections 9.6.1.1, 9.6.1.2]

Sections 9.6.1.1, 9.6.1.2

9.6.1.1* –

~~Normally unoccupied, remote standalone telecommunications structures with a gross floor area of less than 1500 ft ^{2} (139 m ^{2}) using lead-acid or nickel-cadmium battery technology~~

Traditional standby power applications shall not be required to ~~have the detection~~ have detection required in 4.8.1.

9.6.1.2* –

Lead-acid and nickel-cadmium ~~battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use the process control system to monitor the smoke detectors~~ batteries listed to UL1973 in systems 600 V dc or less shall not be required to have detection required in 4.8.1.

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-96

Submitter Information Verification

Submitter Full Name: Richard Kluge
Organization: NEBScore Inc.
Affiliation: ATIS
Street Address:
City:
State:
Zip:
Submittal Date: Fri Mar 15 09:31:03 EDT 2024
Committee: ESS-AAA

Public Comment No. 168-NFPA 855-2024 [Sections 9.6.1.1, 9.6.1.2]

Sections 9.6.1.1, 9.6.1.2

9.6.1.1*

Normally ~~unoccupied, remote standalone~~ unoccupied standalone telecommunications structures with a gross floor area of less than 1500 ft^2 (139 m^2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1.

9.6.1.2 Normally unoccupied standalone fixed guideway transit or passenger rail system structures with a gross floor area of less than 1500 ft^2 (139 m^2) using lead-acid or nickel-cadmium battery technology shall not be required to have the detection required in 4.8.1.

9.6.1.3 *

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall be allowed to use ~~the~~ their process control system to monitor the smoke detectors required in 4.8.1.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, and add rail transit control exemption similar to telecom and electric utility. Remove "remote" from telecom and omit from rail application as the term it is not defined and it is not necessary to limit the use of this exemption to rural applications if already restricted to lead-acid and nickel-cadmium installations.

Suggested simplifications are welcomed.

Related Item

- TG 24

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: TG 24
Street Address:
City:
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Zip:
Submittal Date: Fri May 24 19:16:09 EDT 2024
Committee: ESS-AAA

Public Comment No. 71-NFPA 855-2024 [New Section after 9.6.1.3]

Comment on CI-184 and CI-185

Statement of Problem and Substantiation for Public Comment

I support the proposed text additions of CI-184 and CI-185.

Related Item

- CI-184 and CI-185

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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City:	
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Submittal Date:	Thu Mar 21 17:21:40 EDT 2024
Committee:	ESS-AAA

Public Comment No. 30-NFPA 855-2024 [Section No. 9.6.1.5]

9.6.1.5*

Smoke and fire detection systems ~~, including the approved supervising station,~~ protecting an ESS with lithium-ion batteries shall be required to provide a secondary power supply capable of 24 hours of power in a nonalarm condition and 2 hours of power in an alarm condition.

Statement of Problem and Substantiation for Public Comment

Power redundancy and other requirements regarding operation of the supervising station are dictated by NFPA 72, Chapter 26. If changes are needed, they should be submitted to NPFA 72, SIG-SSS Technical Committee for consideration.

Related Item

- FR-96

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Affiliation:	ATIS
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City:	
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Submittal Date:	Wed Mar 13 13:35:30 EDT 2024
Committee:	ESS-AAA

Public Comment No. 133-NFPA 855-2024 [New Section after 9.6.1.6]

9.6.1.7

The smoke and fire detection systems shall be inspected by the AHJ after commissioning of the ESS is complete and before the ESS is placed into operation.

Statement of Problem and Substantiation for Public Comment

Large scale ESS projects can have thousands of fire devices and signals that need to be commissioned and tested. This addition would ensure installers are calling for inspections prior to operation. And by clarifying the timing at which the AHJ inspections are, this allows the contractors to make progress on commissioning all components of the ESS, including the fire systems, until they are completely finished and ready for the AHJ to do inspections and issue the Operational Permit. This would simplify inspections for the AHJs and create consistency on timing for installers.

Related Item

- FR-96

Submitter Information Verification

Submitter Full Name:	Daniel Clark
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Street Address:	
City:	
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Submittal Date:	Wed May 22 18:13:58 EDT 2024
Committee:	ESS-AAA

Public Comment No. 103-NFPA 855-2024 [Section No. 9.6.2]

9.6.2 Fire Control and Suppression.

9.6.2.1

Rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.

9.6.2.2 Lead-Acid and Nickel-Cadmium Battery Systems.

9.6.2.2.1

Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 shall not be required to have a fire suppression system installed.

9.6.2.2.2

Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed.

9.6.2.2.3*

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire suppression system installed.

9.6.2.2.4

Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.

9.6.2.3

Where more than one ESS technology is present within a fire area, the fire protection systems shall be designed to protect the greatest hazard.

9.6.X.X.

(x) NFPA 2010

Statement of Problem and Substantiation for Public Comment

Various proposals by the NFPA 855 TC, Task Group on Fire Suppression and Explosion Protection have proposed significant revisions to section 9.6.2.

In a proposed section 9.6.2.2., an additional list of referenced NFPA standards should include NFPA 2010.

This submitter has previously provided input on inclusion of NFPA 2010 in section 4.9.3.2; Additional inclusion of reference to NFPA 2010 in section 9.6.X.X would be consistent with the revisions to be made in section 4.9.3.2

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 101-NFPA 855-2024 [Section No. 4.9.3.2]	consistency in referencing NFPA 2010

Related Item

- Consistency in referencing NFPA 2010

Submitter Information Verification

Submitter Full Name: Lance Harry
Organization: Fireaway Inc.
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City:
State:
Zip:
Submittal Date: Mon May 13 15:21:22 EDT 2024
Committee: ESS-AAA

Public Comment No. 122-NFPA 855-2024 [Section No. 9.6.2]

9.6.2 Fire Control and Suppression, and Thermal Runaway Protection .

9.6.2.1

Rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided with fire control and suppression system or thermal runaway protection system in accordance with Section 4.9, unless modified by this chapter.

9.6.2.2 Lead-Acid and Nickel-Cadmium Battery Systems.

9.6.2.2.1

Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 shall not be required to have a fire suppression system installed.

9.6.2.2.2

Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed.

9.6.2.2.3*

Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire suppression system installed.

9.6.2.2.4

Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.

9.6.2.3

Where more than one ESS technology is present within a fire area, the fire protection systems shall be designed to protect the greatest hazard.

Statement of Problem and Substantiation for Public Comment

Thermal Runaway Protection systems are a newer technology that has shown promise to protect ESS systems.

Related Item

- FR-45

Submitter Information Verification

Submitter Full Name: Brad Stilwell
Organization: Fike Corporation
Street Address:
City:

State:	
Zip:	
Submittal Date:	Wed May 22 16:20:49 EDT 2024
Committee:	ESS-AAA

Public Comment No. 52-NFPA 855-2024 [Section No. 9.6.2]

9.6.2 Fire Control and Suppression.

9.6.2.1

Rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.

~~9.6.2.2.3~~ * –

~~Lead~~

9.6.2.2 ~~Lead-Acid and Nickel-Cadmium Battery Systems.~~

~~9.6.2.2.1~~ –

~~Lead-acid and nickel-cadmium battery systems less than 50 V ac, 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that comply with NFPA 76 shall not be required to have a fire suppression system installed.~~

~~9.6.2.2.2~~ –

~~Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, which is limited to not more than 10 percent of the floor area on the floor on which the ESS is located, shall not be required to have a fire suppression system installed.~~

Traditional standby power applications or lead -acid and nickel-cadmium

~~battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations~~

batteries listed to UL1973 in systems 600 V dc or less shall not be required to have a fire suppression system installed.

9.6.2.~~2.4~~ –

~~Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.~~

~~9.6.2.~~ 3

Where more than one ESS technology is present within a fire area, the fire protection systems shall be designed to protect the greatest hazard.

Statement of Problem and Substantiation for Public Comment

Simplification of the current lead-acid / Ni-Cd exemption based on definition of traditional standby power applications for flooded cells and listing to UL 1973 when such products are available as is increasingly the case for VRLA.

Related Item

- FR-47

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Affiliation: ATIS
Street Address:
City:
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Submittal Date: Fri Mar 15 09:40:50 EDT 2024
Committee: ESS-AAA

Public Comment No. 190-NFPA 855-2024 [New Section after 9.6.2.1]

9.6.2.1.1 Fire control and suppression is not required for Outdoor remote locations.

Statement of Problem and Substantiation for Public Comment

Table 9.5.2 points to this chapter as required for 9.6.2. There are no requirement currently in this chapter for outdoor units other than protection of exposures. It needs to be clear we do not require suppression of remote outdoor units. Also need to change table To NO for remote.

Should also address Outdoor locations with exposures in Chapter 4.6.2

Related Item

- FR 46

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Street Address:
City:
State:
Zip:
Submittal Date: Mon May 27 12:10:42 EDT 2024
Committee: ESS-AAA

Public Comment No. 213-NFPA 855-2024 [New Section after 9.6.2.1]

9.6.2.1.1 Water based fire suppression systems protecting room and spaces including walk-in ESS units shall utilize double interlocked preaction systems.

Statement of Problem and Substantiation for Public Comment

Required safety measure to assure water is applied to batteries in a false alarm condition.

Related Item

- CI 184

Submitter Information Verification

Submitter Full Name:	Paul Hayes
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Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue May 28 09:54:44 EDT 2024
Committee:	ESS-AAA

Public Comment No. 189-NFPA 855-2024 [Section No. 9.6.2.1]

9.6.2.1*

Rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.

A.9.6.2.1 **Per Annex A.4.9.1 – this section is meant to be applied to exposure and not internal to enclosures or cabinets.**

Statement of Problem and Substantiation for Public Comment

It is not always clear that this section is meant to provide protection to the exposures and not the enclosures or cabinets.

Related Item

- FR 46

Submitter Information Verification

Submitter Full Name: Paul Hayes
Organization: The Hiller Companies/American
Street Address:
City:
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Submittal Date: Mon May 27 12:07:17 EDT 2024
Committee: ESS-AAA

Public Comment No. 320-NFPA 855-2024 [Section No. 9.6.2.1]

9.6.2.1

Rooms or areas within ~~buildings and outdoor walk-in units containing~~ buildings containing ESSs shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.

Statement of Problem and Substantiation for Public Comment

This proposal is part of a series of proposals deleting fire suppression requirements targeting walk-in units. The only reason for the walk-in unit sections was to treat them the same as a building for fire protection requirements, primarily fire suppression. The installation of the fire suppression is not practical and is contrary to the requirement that large-scale fire testing document a unit can be consumed by fire and not propagate to other ESS units.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 311-NFPA 855-2024 [Section No. 4.9.1]	
Public Comment No. 316-NFPA 855-2024 [Sections 9.5.3.1.4.1, 9.5.3.1.4.2]	
Public Comment No. 319-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 322-NFPA 855-2024 [Sections 9.3.1.2, 9.3.1.3]	

Related Item

- CI-185 and FR-46

Submitter Information Verification

Submitter Full Name: Robert Davidson
Organization: Davidson Code Concepts, LLC
Street Address:
City:
State:
Zip:
Submittal Date: Thu May 30 14:48:42 EDT 2024
Committee: ESS-AAA

Public Comment No. 324-NFPA 855-2024 [Section No. 9.6.2.1]

9.6.2.1

Rooms or areas within buildings and outdoor walk-in units containing ESSs shall be provided with fire control and suppression in accordance with Section 4.9, unless modified by this chapter.

9.6.2.1.1 Water based fire suppression systems protecting rooms and spaces shall utilize double interlocked preaction systems.

Statement of Problem and Substantiation for Public Comment

A system failure of a water-based fire suppression system can cause an ESS catastrophic event. It is important to provide protection against inadvertent water release impacting the space the ESS is located within.

Related Item

- CI-184

Submitter Information Verification

Submitter Full Name:	Robert Davidson
Organization:	Davidson Code Concepts, LLC
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu May 30 15:11:26 EDT 2024
Committee:	ESS-AAA

Public Comment No. 163-NFPA 855-2024 [Section No. 9.6.2.2]

9.6.2.2 Lead-Acid and Nickel-Cadmium Battery Systems.

The requirements for fire suppression systems of 4. 9.

~~6.~~

2 and 4 .

~~2.1~~

~~Lead~~

9.3 shall not apply to lead -acid and nickel-cadmium

~~battery systems less than 50 V ac,~~

batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(5) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that

~~comply~~

(1) are in compliance with NFPA 76

~~shall not be required to have a fire suppression system installed.~~

~~**9.6.2.2.2**~~ –

~~Lead-acid battery systems in uninterruptable power supplies listed and labeled in accordance with the application used for standby power applications, which is limited to not more than 10 percent~~

(1)

(2) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which

~~the ESS is located, shall not be required to have a fire suppression system installed.~~

~~**9.6.2.2.3**~~ * –

~~Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire suppression system installed.~~

~~**9.6.2.2.4**~~ –

~~Lead-acid and nickel-cadmium battery systems listed to UL 1973 shall not be required to have a fire suppression system installed.~~

(1) they are located.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggested simplifications are welcomed.

Related Item

- TG 24

Submitter Information Verification

Submitter Full Name: Richard Kluge
Organization: NEBScore Inc.
Affiliation: TG 24
Street Address:
City:
State:
Zip:
Submittal Date: Fri May 24 18:08:22 EDT 2024
Committee: ESS-AAA

Public Comment No. 264-NFPA 855-2024 [New Section after 9.6.2.3]

9.6.2.4 Lithium-Ion Battery Systems

The automatic fire control and suppression system protecting lithium-ion battery systems shall be in accordance with 4.9.2 and this section.

9.6.2.4.1 Alternate Automatic Fire Control and Suppression Systems - Lithium-Ion

9.6.2.4.2 Other automatic fire control and suppression systems shall be permitted based on reports issued as a result of fire and explosion testing in accordance with 9.1.5.

9.6.2.4.3* The automatic fire control and suppression systems shall comply with the following standards, or their equivalenet, as appropriate:

(1) NFPA 15

(2) NFPA 750

A.9.6.2.4.3 Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific ESS installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer’s system through fire and explosion testing in accordance with 9.1.5 to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750. See G.6.1.3 for more information on the use of water mist systems with LIB-based ESSs.

Statement of Problem and Substantiation for Public Comment

FR-45 edited Section 4.9.3.2, a general requirement that is applicable to all battery technologies, to only be applicable to lithium ion battery systems. This information should be in chapter 9, as the other battery specific technology exemptions and specific protection requirements were moved to this chapter. FR-45 is limiting other battery technologies based on one specific battery technology, lithium-ion.

Related Item

- FR-45

Submitter Information Verification

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Submittal Date: Wed May 29 18:21:27 EDT 2024
Committee: ESS-AAA

Public Comment No. 172-NFPA 855-2024 [New Section after 9.6.3]

9.6.4* Extinguishing water retention and disposal

Water shall be collected and properly disposed of where required by the AHJ.

Statement of Problem and Substantiation for Public Comment

Where significant amounts of Lithium-Ion-Batteries have burnt and a water based extinguishing system has been activated, the waste water is likely to be contaminated with heavy metals and organic components.
The handling of this waste water should be adjusted to the location of the energy storage system. Where sensitive nature and organisms are present the water from fixed fire fighting systems for the expected operation time should be collected.

A research paper lining out which contaminants are to be expected can be found in: Arnaud Bordes, Arnaud Papin, Guy Marlair, Théo Claude, Ahmad El-Masri, et al.. Assessment of Run-Off Waters Resulting from Lithium-Ion Battery Fire-Fighting Operations. Batteries, 2024, 10(4), pp.118. 10.3390/batteries10040118. ineris-04528776

Related Item

- 9.6.3.1

Submitter Information Verification

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Submittal Date: Mon May 27 04:04:03 EDT 2024
Committee: ESS-AAA

Public Comment No. 53-NFPA 855-2024 [Section No. 9.6.3]

9.6.3 Water Supply.

9.6.3.1

Sites where nonmechanical ESSs are installed shall be provided with a permanent source of water for fire protection in accordance with 4.9.4, unless modified by this chapter.

9.6.3.2 Lead-Acid and Nickel-Cadmium Systems.

9.6.3.2.1~~*~~ –

~~Normally unoccupied, standalone telecommunications structures with a gross floor area of less than 1500 ft^2 (139 m^2) with lead-acid and nickel-cadmium battery systems less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations shall~~

-

Traditional standby power applications shall not be required to have a fire water supply.

9.6.3.2.2

Lead-acid and nickel-cadmium ~~battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations shall not be required to have a fire water supply.~~

~~**9.6.3.2.3**~~ –

~~Lead-acid and nickel-cadmium~~ batteries listed to UL 1973 in systems 600 V dc or less shall not be required to have a fire water supply.

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-130

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Committee:	ESS-AAA

Public Comment No. 164-NFPA 855-2024 [Section No. 9.6.3.2]

9.6.3.2 Lead-Acid and Nickel-Cadmium Systems.

~~**9.6.3.2.1**~~ ~~*~~ –

~~Normally unoccupied, standalone telecommunications structures with a gross floor area of less than 1500 ft ^{2} (139 m ^{2}) with~~

The requirements of 4.9.4 shall not apply to lead-acid and nickel-cadmium

~~battery systems less than 60 V dc that are in telecommunications facilities for installations of communications equipment~~

batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

(4) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of

~~communications utilities~~

(1) a transit authority and located outdoors or in building spaces used exclusively for such installations

~~shall not be required to have a fire water supply.~~

~~**9.6.3.2.2**~~ –

~~Lead-acid and nickel-cadmium battery systems that are used for dc power for control of substations and control or orderly shutdown of generating stations~~

(1)

(2) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of

~~the electric utility~~

(1) communications utilities and located outdoors or in building spaces used exclusively for such installations

~~shall not be required to have a fire water supply.~~

~~**9.6.3.2.3**~~ –

~~Lead-acid and nickel-cadmium batteries listed to UL 1973 in systems 600 V dc or less shall not be required to have a fire water supply~~

(1) that are in compliance with NFPA 76

(2) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located .

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggested simplifications are welcomed.

Related Item

- TG 24

Submitter Information Verification

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Submittal Date:	Fri May 24 18:10:45 EDT 2024
Committee:	ESS-AAA

Public Comment No. 143-NFPA 855-2024 [Section No. 9.6.4]

9.6.4 Integrated and Commissioning of Active and Passive ~~Fire~~ Protection and Life Safety System Test.

9.6.4.1 Basic Testing.

Where installations involving two or more integrated ~~fire~~ protection or life safety systems are present, the systems shall be tested to verify the operation and function of such systems in accordance with 9.6.4.1.1 and 9.6.4.1.2.

9.6.4.1.1

When a ~~fire~~ protection or life safety system is tested, the response of integrated ~~fire~~ protection and life safety systems shall be verified.

9.6.4.1.2

After repair or replacement of equipment, required retesting of integrated systems shall be limited to verifying the response of ~~fire~~ protection or life safety functions initiated by repaired or replaced equipment.

9.6.4.2 NFPA 4 Testing.

9.6.4.2.1

For new buildings, integrated testing in accordance with NFPA 4 shall be conducted prior to the issuance of a certificate of occupancy.

9.6.4.2.2

For existing buildings, integrated testing in accordance with NFPA 4 shall be conducted at intervals not exceeding 5 years unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4.

9.6.4.3 NFPA 3 Commissioning.

The procedures, methods, and documentation for the commissioning of active and passive ~~fire~~ protection and life safety systems and their interconnections with other building systems shall be in accordance with NFPA 3.

Statement of Problem and Substantiation for Public Comment

as other critical safety system exist beyond fire and life safety. The Concern is the user may point to the word fire and bypass the other systems. Removing the word fire, covers the other critical safety systems that must me tested in coordination with the fire system and the life safety systems such as the BMS and the CGCRS.

Related Item

- PI 97

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Submittal Date: Fri May 24 08:38:18 EDT 2024

Committee: ESS-AAA

Public Comment No. 165-NFPA 855-2024 [Section No. 9.6.5]

9.6.5 Fire Barriers.

Rooms or spaces containing ESSs shall be separated from other areas of the building by fire barriers with a minimum 2-hour fire resistance rating and horizontal assemblies with a minimum 2-hour fire resistance rating, constructed in accordance with the local building code.

9.6.5.1

Rooms or spaces, containing only ESSs listed to UL 9540 and that are marked as meeting the cell-level performance criteria of UL 9540A, shall be permitted to be separated from other areas of the building with a minimum 1-hour fire resistance rating constructed in accordance with local building codes.

9.6.5.2

Lead-acid and nickel-cadmium

~~battery systems that are used for dc power~~

batteries where used in a stationary standby service consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or

~~orderly~~

(1) safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

~~shall not be required have a 2-hour fire resistance separation from the rest of the building.~~

~~**9.6.5.3**~~ –

~~Lead-acid and nickel-cadmium batteries listed to UL1973 in systems 600 V dc or less~~

(1)

(2) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(3) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(4) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located

shall only require a 1-hour fire resistance separation from the rest of the building.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggested simplifications are welcomed.

Related Item

- TG 24

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Committee: ESS-AAA

Public Comment No. 282-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]

Electrochemical ESSs shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.6.

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium ~~nickel~~ metal chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

Statement of Problem and Substantiation for Public Comment

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 279-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	FR-3
Public Comment No. 281-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	FR-4
Public Comment No. 279-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	
Public Comment No. 281-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	

Related Item

- FR-146

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 307-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]

Electrochemical ESSs shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.6.

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

Additional Proposed Changes

File Name	Description	Approved
NFPA_855_TG_8_-_Tables_Clean_Up_v1_240520_.pdf		

Statement of Problem and Substantiation for Public Comment

This is a comment to revise the associated table to match the format in previous tables. This proposal aligns the order of the chemistries and technologies across tables 1.3, 9.4.1, and 9.6.6 There are no proposed technical changes. For ease of use, the table in terra-view is not modified. The submitted attachment should be based on the lower table found appropriate for this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 308-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	
Public Comment No. 309-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	
Public Comment No. 308-NFPA 855-2024 [Section No. 1.3 [Excluding any Sub-Sections]]	
Public Comment No. 309-NFPA 855-2024 [Section No. 9.4.1 [Excluding any Sub-Sections]]	

Related Item

- FR146

Submitter Information Verification

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Committee:	ESS-AAA

NFPA 855, Task Group 8, New Technologies - Updated Tables 1.3, 9.4.1 and 9.6.6

Version 1, May 20, 2024 (A. Skoskiewicz)

1) Standardized the technology language used in all 3 tables
2) Alphabetized the tables, with "Other" being last
3) Switched to proper footnote callouts (a, b, c), instead of (*, +) and re-arranged sequence
4) Introduced metric conversion to Table 9.4.1 (similar to Table 1.3)
5) Original Screenshots presented first (row 15+), followed by proposed table (row 50+), followed by "Original Table, digital" (row 80+)
6) Proposed Tables have strikethroughs (deleted text) and underlines (added text). No markings for moved text.
7) Added footnotes "b" and "c" to Table 9.6.6 for consistency
8) Added "Reference Line" as part of the Table 9.6.6 Header.
9) Created a single "Other" bucket to lower ambiguity.

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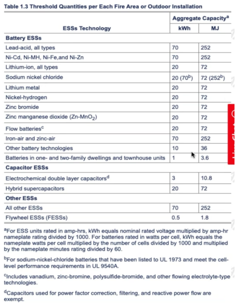

Table 1.3 Threshold Quantities per Each Fire Area or Outdoor Installation

ESSs Technology	Aggregate Capacity[a]	
	kWh	MJ
Battery ESSs		
Lead-acid, all types	70	252
Ni-Cd, Ni-MH, Ni-Fe,and Ni-Zn	70	252
Lithium-ion, all types	20	72
Sodium nickel chloride	20 (70[b])	72 (252[b])
Lithium metal	20	72
Nickel-hydrogen	20	72
Zinc bromide	20	72
Zinc manganese dioxide (Zn-MnO$_2$)	20	72
Flow batteries[c]	20	72
Iron-air and zinc-air	70	252
Other battery technologies	10	36
Batteries in one- and two-family dwellings and townhouse units	1	3.6
Capacitor ESSs		
Electrochemical double layer capacitors[d]	3	10.8
Hybrid supercapacitors	20	72
Other ESSs		
All other ESSs	70	252
Flywheel ESSs (FESSs)	0.5	1.8

[a]For ESS units rated in amp-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b]For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirements in UL 9540A.

[c]Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies.

[d]Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

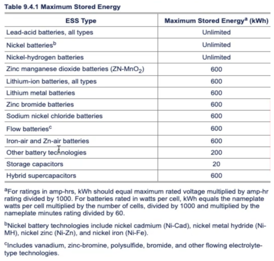

Table 9.4.1 Maximum Stored Energy

ESS Type	Maximum Stored Energy[a] (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries[b]	Unlimited
Nickel-hydrogen batteries	Unlimited
Zinc manganese dioxide batteries (ZN-MnO$_2$)	600
Lithium-ion batteries, all types	600
Lithium metal batteries	600
Zinc bromide batteries	600
Sodium nickel chloride batteries	600
Flow batteries[c]	600
Iron-air and Zn-air batteries	600
Other battery technologies	200
Storage capacitors	20
Hybrid supercapacitors	600

[a]For ratings in amp-hrs, kWh should equal maximum rated voltage multiplied by amp-hr rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multiplied by the number of cells, divided by 1000 and multiplied by the nameplate minutes rating divided by 60.

[b]Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe).

[c]Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies.

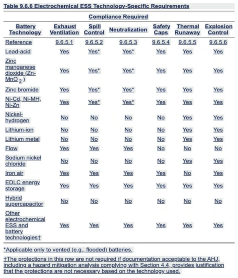

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES PROPOSED TABLES

PROPOSED - Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation

	ESS Technology Type	Aggregate Capacity[a]	
		kWh	MJ
1	Batteries in one- and two-family dwellings and townhouse units	1	3.6
2	Electrochemical double layer capacitors (EDLC)[b]	3	10.8
3	Flow batteries[c]	20	72
4	Flywheel ESSs (FESSs)	0.5	1.8
5	Hybrid supercapacitors	20	72
6	Iron-air and zinc-air	70	252
7	Lead-acid, all types	70	252
8	Lithium-ion, all types	20	72
9	Lithium metal	20	72
10	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
11	Nickel-hydrogen	20	72
12	Sodium nickel chloride	20 (70)[d]	72 (252)[d]
13	Zinc bromide	20	72
14	Zinc manganese dioxide (Zn-MnO$_2$)	20	72
15	All other ESSs technologies	10	36

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

PROPOSED - Table 9.4.1 Maximum Stored Energy

	ESS Technology Type	Maximum Stored Energy[a] (kWh)	
		kWh	MJ
1	Electrochemical double layer capacitors (EDLC)[b] ~~Storage capacitors~~	20	72
2	Flow batteries[c]	600	2160
3	Hybrid supercapacitors	600	2160
4	Iron-air and ~~Zn~~ zinc-air batteries	600	2160
5	Lead-acid ~~batteries~~, all types	Unlimited	Unlimited
6	Lithium-ion ~~batteries~~, all types	600	2160
7	Lithium metal ~~batteries~~	600	2160
8	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn ~~Nickel batteries~~[d]	Unlimited	Unlimited
9	Nickel-hydrogen ~~batteries~~	Unlimited	Unlimited
10	Sodium nickel chloride ~~batteries~~	600	2160
11	Zinc bromide	600	2160
12	Zinc manganese dioxide batteries (Zn-MnO$_2$)	600	2160
13	All other ESS ~~battery~~ technologies	200	720

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

~~[d] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)~~

PROPOSED - Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	~~Battery Technology~~ ESS Technology Type	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
	Reference	**9.6.5.1**	**9.6.5.2**	**9.6.5.3**	**9.6.5.4**	**9.6.5.5**	**9.6.5.6**
1	Electrochemical double layer capacitors (EDLC)[b] ~~energy storage~~	Yes	Yes	Yes	Yes	Yes	Yes
2	Flow batteries[c]	Yes	Yes	Yes	No	No	No
3	Hybrid supercapacitors	No	No	No	No	No	No
4	Iron air and zinc-air	Yes	Yes	Yes	Yes	No	Yes
5	Lead-acid, all types	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
6	Lithium-ion, all types	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Ni-Cd, Ni-MH, Ni-Fe, and Ni-Zn	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
9	Nickel-hydrogen	No	No	No	No	Yes	Yes
10	Sodium nickel chloride	No	No	No	No	Yes	Yes
11	Zinc bromide	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
12	Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes[a]	Yes[a]	Yes	Yes	Yes
13	All other ~~electrochemical~~ ESS ~~and battery~~ techologies[b]	Yes	Yes	Yes	Yes	Yes	Yes

[a] Applicable only to vented (e.g. flooded) batteries

[b] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[b] The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES ORIGINAL TABLES

Table 1.3 - Threshold Quantities per Each Fire Area or Outdoor Installation (as written)

	ESS Technology	Aggregate Capacity[a]	
		kWh	MJ
	Battery ESS		
1	Lead-acid, all types	70	252
2	Ni-Cd, Ni-Mh, Ni-Fe, and Ni-Zn	70	252
3	Lithium-ion, all types	20	72
4	Sodium nickel chloride	20 (70[b])	72 (252[b])
5	Lithium metal	20	72
6	Nickel-hydrogen	20	72
7	Zinc bromide	20	72
8	Zinc manganese dioxide (Zn-MnO$_2$)	20	72
9	Flow batteries[c]	20	72
10	Iron-air and zinc-air	70	252
11	Other battery technologies	10	36
12	Batteries in one- and two-family dwellings and townhouse units	1	3.6
	Capacitor ESSs		
13	Electrochemical double layer capacitors[d]	3	10.8
14	Hybrid supercapacitors	20	72
	Other ESSs		
15	All other ESSs	70	252
16	Flywheel ESSs (FESSs)	0.5	1.8

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] For sodium-nickel-chloride batteries that have been listed to UL 1973 and meet the cell-level performance requirementns in UL 9540A.

[c] Includes vanadium, zinc-bromine, polysulfide-bromide, and other flowing electrolyte-type technologies

[d] Capacitors used for power factor correction, filtering, and reactive power flow are exempt.

Table 9.4.1 Maximum Stored Energy

	ESS Type	Maximum Stored Energy[a] (kWh)
1	Lead-acid batteries, all types	Unlimited
2	Nickel batteries[b]	Unlimited
3	Nickel-hydrogen batteries	Unlimited
4	Zinc manganese dioxide batteries (Zn-MnO$_2$)	600
5	Lithium-ion batteries, all types	600
6	Lithium metal batteries	600
7	Zinc bromide batteries	600
8	Sodium nickel chloride batteries	600
9	Flow batteries[c]	600
10	Iron-air and Zn-air batteries	600
11	Other battery technologies	200
12	Storage capacitors	20
13	Hybrid supercapacitors	600

[a] For ESS units rated in am-hrs, kWh equals nominal rated voltage multiplied by amp-hr nameplate rating divided by 1000. For batteries rated in watts per cell, kWh equals the nameplate watts per cell multipled by the number of cells divided by 1000 and multiplied by the nameplate minutes rating divided by 60

[b] Nickel battery technologies include nickel cadmium (Ni-Cad), nickel metal hydride (Ni-MH), nickel zinc (Ni-Zn), and nickel iron (Ni-Fe)

[c] Includes vanadium, zinc-bromine, polysulfide, bromide, and other flowing electrolyte-type technologies

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

		Compliance Required					
	Battery Technology	Exhaust Ventilation	Spill Control	Neutralization	Safety Caps	Thermal Runaway	Explosion Control
	Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
1	Lead-acid	Yes	Yes *	Yes *	Yes	Yes	Yes
2	Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes *	Yes *	Yes	Yes	Yes
3	Zing bromide	Yes	Yes *	Yes *	Yes	Yes	Yes
4	Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes *	Yes *	Yes	Yes	Yes
5	Nickel Hydrogen	No	No	No	No	Yes	Yes
6	Lithium-ion	No	No	No	No	Yes	Yes
7	Lithium metal	No	No	No	No	Yes	Yes
8	Flow	Yes	Yes	Yes	No	No	No
9	Sodium nickel chloride	No	No	No	No	Yes	Yes
10	Iron air	Yes	Yes	Yes	Yes	No	Yes
11	EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
12	Hybrid supercapacitor	No	No	No	No	No	No
13	Other electrochemical ESS and battery techologies +	Yes	Yes	Yes	Yes	Yes	Yes

* Applicable only to vented (e.g. flooded) batteries

+ The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with section 4.4, provides justification that the protections are not necessary based on the technology used

END END END END END END END END

Public Comment No. 327-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]

Electrochemical ESSs shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.6.

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.~~5~~ 6 .1	9.6.~~5~~ 6 .2	9.6.~~5~~ 6 .3	9.6.~~5~~ 6 .4	9.6.~~5~~ 6 .5	9.6.~~5~~ 6 .6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO$_2$)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

Statement of Problem and Substantiation for Public Comment

Typos leading to wrong referenced sections.

Related Item

- none

Submitter Information Verification

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Submittal Date: Thu May 30 15:37:44 EDT 2024

Committee: ESS-AAA

Public Comment No. 331-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]

Electrochemical ESSs shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.6.

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.5.1	9.6.5.2	9.6.5.3	9.6.5.4	9.6.5.5	9.6.5.6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium ~~nickel~~ metal chloride	No	No	No	No	Yes	Yes
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

Statement of Problem and Substantiation for Public Comment

Creates a more appropriate category response to the current sodium nickel chloride terminology and avoids ambiguity with addition of nickel-iron to list of battery types

“Sodium metal chloride” is commonly used terminology for a closely related family of molten salt battery chemistries, typically operating in a temperature range of 200 to 350 Celsius. This battery family uses a spectrum of metal cathodes including nickel, iron, and nickel-iron blends with a 40+ year history of development. With the proposal to explicitly add the nickel-iron chemistry to the table, the distinction of sodium metal chloride high temperature batteries is particularly important. The incorporation of sodium metal chloride nickel-iron blends provides materially equivalent safety profile to pure sodium-nickel-chloride as evidenced in this 1998 paper from NREL “Current Status of Health and Safety Issues of Sodium/Metal Chloride (Zebra) Batteries” documenting the hazards of this class of batteries: https://www.nrel.gov/docs/fy99osti/25553.pdf.

Related Item

- FR-146
- FR-3
- FR-4

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 91-NFPA 855-2024 [Section No. 9.6.6 [Excluding any Sub-Sections]]

Electrochemical ESSs shall comply with the applicable sections of Chapters 4 and 9 as specified in Table 9.6.6.

Table 9.6.6 Electrochemical ESS Technology-Specific Requirements

	Compliance Required					
Battery Technology	**Exhaust Ventilation**	**Spill Control**	**Neutralization**	**Safety Caps**	**Thermal Runaway**	**Explosion Control**
Reference	9.6.~~5~~ 6 .1	9.6.~~5~~ 6 .2	9.6.~~5~~ 6 .3	9.6.~~5~~ 6 .4	9.6.~~5~~ 6 .5	9.6.~~5~~ 6 .6
Lead-acid	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc manganese dioxide (Zn-MnO_2)	Yes	Yes*	Yes*	Yes	Yes	Yes
Zinc bromide	Yes	Yes*	Yes*	Yes	Yes	Yes
Ni-Cd, Ni-MH, Ni-Zn	Yes	Yes*	Yes*	Yes	Yes	Yes
Nickel-hydrogen	No	No	No	No	Yes	Yes
Lithium-ion	No	No	No	No	Yes	Yes
Lithium metal	No	No	No	No	Yes	Yes
Flow	Yes	Yes	Yes	No	No	No
Sodium nickel chloride	No	No	No	No	Yes	Yes
Sodium sulfur	No	No	No	No	Yes	No
Iron air	Yes	Yes	Yes	Yes	No	Yes
EDLC energy storage	Yes	Yes	Yes	Yes	Yes	Yes
Hybrid supercapacitor	No	No	No	No	No	No
Other electrochemical ESS and battery technologies†	Yes	Yes	Yes	Yes	Yes	Yes

*Applicable only to vented (e.g., flooded) batteries.

†The protections in this row are not required if documentation acceptable to the AHJ, including a hazard mitigation analysis complying with Section 4.4, provides justification that the protections are not necessary based on the technology used.

Statement of Problem and Substantiation for Public Comment

•Exhaust ventilation is not needed.
The NAS® battery does not produce any exhaust during normal operation. Forced air ventilation is used for cooling purposes only. Under abnormal conditions, ventilation is stopped, and the air inlet and air outlet ports of the container enclosure are closed.
• Spill Control is not needed.
NAS® chemicals are contained in hermetically sealed cells. Cells are embedded in sand inside the

module. The modules are enclosed in the battery container. In case of cell leakage or cell rupture the chemicals are contained in the module housing and solidify when cooling below operation temperature.

- Neutralization is not needed.

As stated above, no spill control is needed. Therefore, also no neutralization is needed. The chemicals are contained in hermetically sealed cells and any leakage would be contained in the module. Chemicals solidify when cooling below operation temperature.

- Safety caps is not needed.

No gas species is formed by the chemical reactions in the cell. Cell venting is not foreseen by cell design. Gas pressure does not build up by chemical reactions. NAS® cells are hermitically sealed.

- Thermal Runaway protection is needed.

Without appropriate safety measures, one ignited battery cell may cause thermal runaway in the module resulting in extremely high temperatures, fire, smoke, and toxic gas release.
A SO2 blast and Plume study has been conducted for a specific project in the US. If the committee requests, this study can be shared for the review in the future.

- Explosion control is not needed

No release of combustible or flammable gases by the chemicals Na and S. Sodium is a metal and Sulfur an inorganic material.

The NAS® batteries have safety features to prevent such a thermal runaway event and show a specific behavior as in the documents in the link.

For more details, please refer to the documentation describing the security metrics of the NAS® at the link: https://web.tresorit.com/l/SonJ0#lRHsZkJsbEu-m16bSfnEow

Related Item

- FR-146

Submitter Information Verification

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Submittal Date: Thu May 02 07:43:55 EDT 2024
Committee: ESS-AAA

Public Comment No. 152-NFPA 855-2024 [Section No. 9.6.6.1 [Excluding any Sub-Sections]]

Where required by Table 9.6.6 or elsewhere in this standard, exhaust ventilation during normal operation shall be provided for ~~rooms, enclosures, walk-in units, and cabinets~~ ESS as follows:

(1) ESS rooms and walk-in units shall use mechanical exhaust ventilation in accordance with 9.6.6.1.5.

(2) Outdoor ESS cabinets shall use either mechanical or natural exhaust ventilation in accordance with 9.6.6.1.4 or 9.6.6.1.5.

Statement of Problem and Substantiation for Public Comment

The use of multiple terms such as cabinets, enclosures or rooms causes confusion and allows opening for other terms to be excluded. Requirement is for all ESS.

Tables need to be confirmed with the right point back with additions and deletions

Related Item

- FR 156

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Fri May 24 14:48:26 EDT 2024
Committee: ESS-AAA

Public Comment No. 73-NFPA 855-2024 [New Section after 9.6.6.1.2]

Commentary on CI-155

Statement of Problem and Substantiation for Public Comment

I don't think any reference to abnormal conditions belongs in a section on normal ventilation. If the information is valuable it might be good to include in the annex as an item related to 9.6.6.1.

Related Item

- CI-155

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Thu Mar 21 17:36:13 EDT 2024
Committee: ESS-AAA

Public Comment No. 225-NFPA 855-2024 [Section No. 9.6.6.1.2]

9.6.6.1.2* Abnormal Conditions.

Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.6.6.

A.9.6.5.1.2

This section is intended to address hazards associated with the release of flammable gases from ESS during abnormal charging and thermal runaway condition. This section is not intended to address hazards associated with the release of toxic gases during abnormal charging or thermal runaway conditions (see Annex B4.5).

Statement of Problem and Substantiation for Public Comment

Annex notes provides clarifcation to the requirments of toxic evaluation under fire and Thermal Runaway to the new section B4.5.

Related Item

- CI 106

Submitter Information Verification

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Submittal Date: Tue May 28 10:51:33 EDT 2024
Committee: ESS-AAA

Public Comment No. 240-NFPA 855-2024 [Section No. 9.6.6.1.2]

9.6.6.1.2 Abnormal Conditions.

Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.6.6.

Statement of Problem and Substantiation for Public Comment

Committee input on toxic CI 104, 155 requested input on adding Toxics to the tables. TG 6 has provided guidance to Toxics and first responders in the Annex. As such no new toxic section has been add and modifications to the tables are not required.

Related Item

- CI 155 • CI 104

Submitter Information Verification

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Submittal Date: Wed May 29 09:53:38 EDT 2024

Committee: ESS-AAA

Public Comment No. 153-NFPA 855-2024 [Section No. 9.6.6.1.3]

9.6.6.1.3 Indoor ESS Cabinets.

Exhaust ventilation for ~~ESS cabinets installed~~ ESS installed indoors shall include an evaluation of the air movement for both the ~~cabinet and~~ ESS and the room as the basis of the design.

A.9.6.6.1.3 This assumes that the ESS enclosure is contained. If it is an open rack system, then 9.6.6.1 would apply.

Statement of Problem and Substantiation for Public Comment

The use of the term cabinet is restrictive and should apply to indoor ESS regardless of the perceived ESS type.

Related Item

- FR 156

Submitter Information Verification

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Submittal Date: Fri May 24 14:53:07 EDT 2024
Committee: ESS-AAA

Public Comment No. 154-NFPA 855-2024 [Section No. 9.6.6.1.4]

9.6.6.1.4* Outdoor Cabinets.

Natural exhaust ventilation for outdoor cabinets shall be designed to limit the maximum average concentration of flammable gas to below 25 percent of the lower flammable limit (LFL) of the total volume during the worst-case conditions, including simultaneous "boost" charging of all the batteries~~, in accordance with nationally recognized standards~~ .

Statement of Problem and Substantiation for Public Comment

Intend is maintain below 25% LFL and not exactly 25%. Additionally in accordance with nationally recognized standards, since the standards are not defined, this provides little value.

Related Item

- FR 157

Submitter Information Verification

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Submittal Date: Fri May 24 14:59:43 EDT 2024
Committee: ESS-AAA

Public Comment No. 33-NFPA 855-2024 [Section No. 9.6.6.1.4]

9.6.6.1.4* Outdoor Cabinets.

Natural exhaust ventilation for outdoor cabinets shall be designed to limit ~~the maximum average concentration~~ the concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume during the worst-case conditions, including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards.

Statement of Problem and Substantiation for Public Comment

Not clear what a "maximum average" is. It was not part of the related PI and nothing in the FR-157 explains its need or details. Is it averaged over time? Over volume? If there was objections to the term "maximum" maybe best to delete both "maximum" and "average" and state simply the concentration must be limited to 25% of the LFL. If there is concern that "limited" can be misinterpreted to mean lower limit and not maximum limit, then delete "average" and retain "maximum".

Related Item

- FR-157

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Submittal Date:	Thu Mar 14 09:23:52 EDT 2024
Committee:	ESS-AAA

Public Comment No. 35-NFPA 855-2024 [Section No. 9.6.6.1.5]

9.6.6.1.5 Mechanical Exhaust Ventilation.

Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following:

(1) Where hydrogen is the gas generated, an exhaust ventilation rate based on hydrogen generation estimates sufficient to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room, walk-in unit, or cabinet during the worst-case conditions, including simultaneous “boost” charging of all the batteries, in accordance with nationally recognized standards

(2) An exhaust ventilation rate based on the area of not less than 1 $ft^3/min/ft^2$ (5.1 $L/sec/m^2$) of floor area of the room, walk-in unit, ~~enclosure, container,~~ or cabinet

9.6.6.1.5.1

Required mechanical exhaust ventilation systems shall be installed in accordance with the manufacturer’s installation instructions and local building, mechanical, and fire codes.

9.6.6.1.5.2

Required mechanical exhaust ventilation systems shall either be supervised by an approved central, proprietary, or remote station service in accordance with *NFPA 72* or initiate an audible and visual signal at an approved, constantly attended location.

9.6.6.1.5.3

Mechanical exhaust ventilation shall be either continuous or activated by a gas detection system in accordance with 9.6.6.1.5.4.

9.6.6.1.5.4*

Where gas detection is used to activate exhaust ventilation in accordance with 9.6.6.1.5.3, rooms, walk-in units, ~~enclosures, walk-in containers,~~ and cabinets containing ESSs shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the mechanical exhaust ventilation system when the level of flammable gas detected in the room, walk-in unit, enclosure, container, and cabinet exceeds 25 percent of the LFL of the flammable gas mixture.

(2) The mechanical exhaust ventilation system shall remain on until the flammable gas detected is less than 25 percent of the LFL of the flammable gas mixture.

(3) The gas detection system shall be provided with a minimum of 2 hours of standby power.

(4) Failure of the gas detection system shall annunciate a trouble signal at an approved central, proprietary, or remote station in accordance with *NFPA 72* or at an approved, constantly attended location.

Statement of Problem and Substantiation for Public Comment

The preferred terms are ESS rooms, walk-in units, and cabinets. Enclosure and containers are either cabinets or walk-in units. Walk-in units and walk-in containers are the same thing.

Related Item

- PI-333

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Submittal Date:	Thu Mar 14 09:41:22 EDT 2024
Committee:	ESS-AAA

Public Comment No. 261-NFPA 855-2024 [Section No. 9.6.6.1.5.3]

9.6.6.1.5.3

Mechanical exhaust ventilation ~~shall be~~ system and it componets shall

1. Be either continuous or activated by a gas detection system in accordance with 9.6.6.1.5.4 .

2. Remain on to ensure the flammable gas does not accumulate and exceed 25 percent on average of the LFL of the flammable gas mixture or of the individual components.

3. be considered a critical safety system and shall comply with section 4.10.

-

Statement of Problem and Substantiation for Public Comment

Adding the requirement of the new power chapter 4.10 system instead of set standby power requirements. Removing the multiple terms for ESS as all ESS that meet this condition require these condition. Also provide additional clarity around the understanding of 25% LFL conditions. Additional changed to provide consistency with the terms used in the explosion chapter.

Related Public Comments for This Document

Related Comment	**Relationship**
Public Comment No. 155-NFPA 855-2024 [Section No. 9.6.6.1.5.4]	

Related Item

- • FR 157

Submitter Information Verification

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Submittal Date: Wed May 29 16:09:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 72-NFPA 855-2024 [New Section after 9.6.6.1.5.4]

Commentary on CI-160

Statement of Problem and Substantiation for Public Comment

I am opposed to mandating Emergency Level backup power for mechanical ventilation that is part of normal operation. For lead-acid deployments that require ventilation, there is no loss history to justify the added expense and complexity of emergency power utilization for these systems. Best practice for lead-acid or NiCd or other aqueous types would be to power exhaust ventilation fans from the same source as the battery charging system, so if there is no ventilation power, there is no charging and no hydrogen generation.

Related Item

- CI-160

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Submittal Date: Thu Mar 21 17:27:26 EDT 2024
Committee: ESS-AAA

Public Comment No. 155-NFPA 855-2024 [Section No. 9.6.6.1.5.4]

9.6.6.1.5.4*

Where gas detection is used to activate exhaust ventilation in accordance with 9.6.6.1.5.3, ~~rooms, walk-in units, enclosures, walk-in containers, and cabinets containing ESSs~~ ESSs shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the mechanical exhaust ventilation system when the level of flammable gas ~~detected in the room, walk-in unit, enclosure, container, and cabinet exceeds~~ detected exceeds 25 percent of the LFL of the flammable gas mixture.

(2) ~~The mechanical exhaust ventilation system shall remain on until the flammable gas detected is less than 25 percent of the LFL of the flammable gas mixture.~~

(3) ~~The gas detection system shall be provided with a minimum of 2 hours of standby power.~~

(4) Failure of the gas detection system shall annunciate a trouble signal at an approved central, proprietary, or remote station in accordance with *NFPA 72* or at an approved, constantly attended location.

Statement of Problem and Substantiation for Public Comment

Adding the requirement of the new power chapter 4.10 system instead of set standby power requirements. Removing the multiple terms for ESS as all ESS that meet this condition require these condition. Also provide additional clarity around the understanding of 25% LFL conditions. Additional changed to provide consistency with the terms used in the explosion chapter.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 261-NFPA 855-2024 [Section No. 9.6.6.1.5.3]	

Related Item

- CI 160

Submitter Information Verification

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Submittal Date: Fri May 24 15:19:31 EDT 2024
Committee: ESS-AAA

Public Comment No. 36-NFPA 855-2024 [Section No. 9.6.6.2.3]

9.6.6.2.3

In rooms ~~, buildings,~~ or areas protected by water-based fire protection systems, the capacity of the spill containment system shall accommodate the capacity of the expected fire protection system discharge for a period of 10 minutes.

Statement of Problem and Substantiation for Public Comment

Consistent with the change made to 9.6.6.1.5.4 on spill control, the containment capacity of the spill control system should be sized for a system discharge when the ESS and sprinkler are in the same room or area. They can be in the same building and still be in different rooms and areas, so "building" should be removed.

Related Item

- FR-75

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 333-NFPA 855-2024 [Section No. 9.6.6.5]

9.6.6.5* Thermal Runaway Protection.

Where required by Table 9.6.6, a listed device evaluated as part of the ESS or other approved method shall be provided to manage charging and discharging during normal operation of the ESS to maintain batteries and capacitors within their operating parameters and preclude thermal runaway.

9.6.6.5.1

Thermal runaway protection shall not be required for vented (e.g., flooded) lead-acid and Ni-Cd batteries.

9.6.6.5.2

Thermal runaway protection shall be permitted to be provided by the battery management system or a capacitor ESS management system that has been evaluated as part of the UL 1973 or UL 9540 listing.

9.6.6.5.3 Thermal Runaway Protection Systems.

9.6.6.5.3.1

For fluid-based supplemental engineered and pre-engineered thermal runaway protection systems, the system piping and appurtenances shall be compliant with all applicable parts of ~~ASME B31.1 or B31.3.~~ UL 9540 Annex G.

9.6.6.5.3.2

Compliance with ~~ASME B31.1 or B31.3 shall~~ UL 9540 Annex G shall be documented as part of the UL 9540 listing in accordance with 4.6.1.

9.6.6.5.3.3

The effectiveness of the system shall be documented in accordance with 9.1.5.

Statement of Problem and Substantiation for Public Comment

ASME is referenced in Annex G under piping. There are many more critieria outlined in annex G including PRVs, regulators, valves, electrical controls, etc.

Related Item

- FR-48

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Public Comment No. 127-NFPA 855-2024 [Section No. 9.6.6.5.3]

9.6.6.~~5.3~~ 6 Thermal Runaway Protection Systems.

9.6.6.~~5~~ 6 .~~3.~~ 1

For fluid-based supplemental engineered and pre-engineered thermal runaway protection systems, the system piping and appurtenances shall be compliant with all applicable parts of ASME B31.1 or B31.3.

9.6.6.~~5~~ 6 .~~3.~~ 2

Detection and control equipment shall be compliant with NFPA 72 and UL 864.

9.6.6.6.3

Compliance with ASME B31.1 or B31.3 shall be documented as part of the UL 9540 listing in accordance with 4.6.1.

9.6.6.~~5~~ 6 .~~3.3~~ 4

The effectiveness of the system shall be documented in accordance with 9.1.5.

Statement of Problem and Substantiation for Public Comment

Adding the requirement for the controls for Thermal Runaway Protection systems is critical to the system function.

Related Item

- FR-45

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Public Comment No. 177-NFPA 855-2024 [Section No. 9.6.6.5.3]

9.6.6.5.3 Thermal Runaway Protection Systems (TRPS) .

9.6.6.5.3.1

For fluid-based supplemental engineered and pre-engineered thermal runaway protection systems, the system piping and appurtenances shall be compliant with all applicable parts of ASME B31.1 or B31.3.

9.6.6.5.3.~~2~~ 1.1

Compliance with ASME B31.1 or B31.3 shall be documented as part of the UL 9540 listing in accordance with 4.6.1.

9.6.6.5.3.

~~3~~

~~The effectiveness of the system shall be~~

2 **The control system for the Thermal runaway protection system shall be listed to UL 864 for fire panels or UL 508A for industrial control systems.**

9.6.6.5.3.2.1 the TRPS control system shall be listed for releasing.

9.6.6.5.3.2.2 The power requirements of the TRPS shall meet the requirement of chapter 4.10.

9.6.6.5.4* The TRPS shall be commissioned and documented according to section 9.6.4.

A.9.6.6.5.4 While TRPS don’t meet the performance requirements of the NFPA codes, they should be commissioned utilizing the applicable sections of the NFPA codes that most reflective of the system used, such as wet based systems, should be commissioned to the commissioning requirements of NFPA 13,15, 750, or 770 as appropriate. Clean agents should be commissioned to the commissioning requirements of NFPA 2001. Also, they should be commissioned in conjunction with the other critical safety system.

9.6.6.5.5* The TRPS shall be inspected and tested at least annually.

A.9.6.6.5.4 While TRPS don’t meet the performance requirements of the NFPA codes, they should be inspected and tested utilizing the applicable sections of the NFPA codes that is most reflective of the system used. As an example, wet based systems, should be inspected and tested to inspection and testing requirements and schedule per NFPA 13,15, 750, or 770 as appropriate. Clean agents should be inspected and tested to the inspection and testing requirements and schedule of NFPA 2001.

9.6.6.5.3.3 The effectiveness, reliability and survivabitily of the system shall be evalauted and documented in accordance with 9.1.5 .

Statement of Problem and Substantiation for Public Comment

The initial PI only address the mechanical requirement of a TRPS and didn't address the electrical and controls requirements. Addition controls requirments have been added per TG 9.

Related Item

- FR 47

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Public Comment No. 290-NFPA 855-2024 [New Section after 9.6.6.6]

9.6.7* Abnormal Toxic and highly toxic emission detection

Statement of Problem and Substantiation for Public Comment

Form Energy recommends that the committee provide additional information on the proposed toxic gas requirements before implementing into the standard.
1. UL 1973 Section 13 includes toxic emission requirements. NFPA 855 requirements should be reviewed for alignment with the product standard.
2. Data collected during UL 9540A testing is referenced in the proposed text, is it expected that the toxic gas data be collected during the cell vent test or a large-scale fire test?
3. If it is intended that this data be collected during a large scale fire test, is this requirement only for chemistries that can undergo thermal runaway?
4. Will a specific procedure for the toxic data collection be included in updates to UL 9540A?
5. If data is collected at the system level during a large-scale fire test, how are standard electrical components not specific to battery chemistry being taken into account, as those components will also produce toxic gas during a fire?

Related Item

• CI-85 • CI-106

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Public Comment No. 54-NFPA 855-2024 [Section No. 9.6.6.6.1]

9.6.6.6.1

Where required elsewhere in this standard, explosion prevention shall be provided in accordance with this section to safeguard against the release of flammable gases during abnormal charging or thermal runaway conditions.

9.6.6.6.1.1

Explosion prevention shall not be required based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study submitted to the AHJ for review and approval that demonstrates that flammable gas concentrations cannot accumulate and exceed, on average, 25 percent of the LFL.

9.6.6.6.1.2

Explosion control following this standard shall not be required for the following:

(1) ~~Lead-acid and Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76~~

(2) ~~Lead-acid and Ni-Cd battery systems that are and used for dc power for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility located outdoors or in building spaces used exclusively for such installations that complies with the *National Electric Safety Code* or follows the guidelines of IEEE 1635/ASHRAE 21~~

~~Lead-acid battery systems in uninterruptible power supplies listed and labeled in accordance with the application used for standby power applications and housed in a single cabinet in a single fire area in buildings or walk-in units that follow the guidelines of IEEE 1635/ASHRAE 21~~

(3) Traditional standby power applications

(4) Lead-acid and

~~Ni~~

(5) nickel -

~~Cd~~

(6) cadmium batteries listed

~~in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell-level test or equivalent test~~

(7) to UL1973 in systems 600 V dc or less.

9.6.6.6.1.3

Explosion prevention or deflagration venting analysis and design shall be based upon the gas composition and volume identified by fire and explosion testing conducted in accordance with 9.1.5.

Statement of Problem and Substantiation for Public Comment

Improve consistency of lead-acid exemptions.

Related Item

- FR-109

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Public Comment No. 278-NFPA 855-2024 [Section No. 9.6.6.6.1 [Excluding any Sub-Sections]]

Where required elsewhere in this standard, explosion prevention and deflagration venting shall be provided in accordance with this section to safeguard against the ~~release~~ accumulation of flammable gases and provide damage limiting construction during abnormal charging or thermal runaway conditions.

Statement of Problem and Substantiation for Public Comment

Explosion prevention and specifically combustible gas concentration reduction systems (CGCRS) are an effective measure to aid in explosion prevention for ESS. However, they come with significant disadvantages that may lead to catastrophic events if not addressed by providing a deflagration vent system:

1) System reliability: The efficacy of a CGCRS is contingent upon the reliability of a number of sub-systems such as gas detection, control and air exchange system. Failure of one single component (e.g. clogged air filter reducing the efficacy of the fan) may lead to insufficient protection.

2) Potential for maintenance issues: Even stringent maintenance schedules and processes are prone to misses and errors, potentially leading to failure of the explosion prevention system.

3) Considerable time delay: There is a significant time delay between start of off-gas production until the CGCRS is online and effective. This time delay of detection and activation of the system and establishing a save concentration within enclosure can lead to periods during which the enclosure is unprotected if deflagration venting is not provided.

4) High required air exchange rates: Depending on the size and the extent of the thermal runaway event of the battery, a reasonable fan size may not be sufficient to provide protection against explosible concentrations. The two cases below (moderate release case and severe release case) exemplify the problem. The results are based on a simple mass balance analysis (off-gas produced vs off-gas vented).

5) Low efficacy of gas exchange: In the two examples above (moderate case and severe case), uniform gas concentration was considered. The internals of ESS can substantially block the flow of the air dilution system, potentially leading to non-uniform gas concentrations and pockets of gas that cannot be diluted effectively.

Moderate release case:
- Assumption: Uniform gas concentration throughout the container
- 15m3 net gas volume (consistent with a 20ft container)
- Total off-gas produced: 500L (consistent with the off-gas quantity of one 280Ah battery cell)
- Production rate: 200L/min until 500L is reached (consistent with one cell going into thermal runaway)
- CGCRS online upon gas concentration exceeding 0.4% combustible gas concentration (assumption 4% LFL (e.g. hydrogen, LFL of propane is below that))

Maximum gas concentration for different ventilation rates in air changes per hour (ACH):
ACH = 5: 3% (75% LFL)
ACH = 10: 2.7% (68% LFL)
ACH = 20: 2.3% (58% LFL)
ACH = 50: 1.41% (35% LFL)
ACH = 100: 0.8% (20% LFL)

Severe release case:
- Assumption: Uniform gas concentration throughout the container
- 15m3 net gas volume (consistent with a 20ft container)
- Total off-gas produced: 2500L (consistent with the off-gas quantity of five 280Ah battery cells)
- Production rate: 1000L/min until 2500L is reached (consistent with the five cells going into thermal runaway at the same time)
- CGCRS online upon gas concentration exceeding 0.4% combustible gas concentration (assumption

4% LFL)

Maximum gas concentration for different ventilation rates in air changes per hour (ACH)
ACH = 5: 15% (375% LFL)
ACH = 10: 13.6% (340% LFL)
ACH = 20: 11.3% (283% LFL)
ACH = 50: 7.0% (175% LFL)
ACH = 100: 4.0% (100% LFL)

For the moderate case, a low air exchange rate may be sufficient to maintain a combustible gas concentration below 4% but maintaining a concentration level 1% (or 25%LFL) requires high air change rates and large fans. For the severe release case, even a ventilation rate of 100 air changes per hour does not provide sufficient protection. 100 air changes require a fan capacity of 1500m3/hr corresponding to a very large fan size. If a smaller net gas volume is considered (many ESS systems come in sizes smaller than a 20ft container) the required air change rates are even higher. These two example results are in line with the report “Technical reference for Li-ion Battery Explosion Risk and Fire Suppression, DNV Report No.: 2019-1025, Rev. 4” (see https://safety4sea.com/wp-content/uploads/2020/01/DNV-GL-Technical-Reference-for-Li-Ion-Battery-Explosion-Risk-and-Fire-Suppresion-2020_01.pdf). For the highest release rate considered in that study, ventilation rates of 100 air changes per hour were not sufficient to reduce the combustible cloud to an acceptable level.

A similar safety concern has been addressed in NFPA 30B (Code for the manufacture and storage of aerosol products) by providing a combination of explosion prevention and deflagration venting. Aerosol products are usually charged with hydrocarbon gases as the propellant. During this process, there is the potential for small to large releases of combustible gases and thus a resulting deflagration risk. NFPA 30B requires a combination of gas detection / emergency ventilation with explosion venting for combustible gases and vapor hazards. This combined requirement has existed for about 30 years in NFPA 30B (Aerosol Products). The code requires the construction of charging and pump rooms to have damage-limiting construction in accordance with NFPA68 (Section 6.3.4) and the standard also requires combustible gas detection (6.7), with normal plus emergency exhaust to dilute and extract combustible vapors (6.4).

Deflagration venting has been a reliable and successful protection method against gas explosions for many decades. Due to its simplicity, deflagration venting is the most cost effective and at the same time the most reliable explosion protection method available. The unique challenges of BESS systems such as high hydrogen content and high level of congestion can be controlled.

Hydrogen content: The laminar burning velocity of lithium-ion battery off-gases (for 100% SOC and ideal fuel concentration) is between the value for propane and 30% of the laminar burning velocity of Hydrogen.
The laminar burning velocity is a dominant variable during deflagration analysis. BESS off-gas, comprising a substantial amount of hydrogen, exhibits high laminar burning velocities. A high burning velocity leads to a faster consumption of the fuel, heat generation and thus pressure build up. For comparison, propane has a laminar burning velocity of 0.46m/s with a pmax (maximum explosion pressure) of 7.9barg and Hydrogen shows 3.12m/s with a pmax of 6.8barg. Various publications characterize battery off-gas for various chemistries and SOC values. The reported data shows that at 100% SOC and ideal fuel concentration, the laminar burning velocity is below 0.5m/s for LFP chemistries, below 0.7m/s for NMC and LCO batteries and below 1.1m/s for NCA cathode chemistries. The maximum reported pmax values are below 8.5barg. This data is in line with IEP’s study of UL9540A test reports in which the reported burning velocities match this 0.5m/s – 1.1m/s interval. The equations for determining the vent sizes in NFPA68 are valid up to a burning velocity of 3m/s, almost 3 times the value observed on BESS vent gases. In terms of market share, currently NMC is the most dominant chemistry with LFP poised to overtake NMC as the most prevalent chemistry until 2030.

Congestion: NFPA68 considers congestion within the enclosure.
Congested enclosures can result in significantly increased Preds (maximum reduced explosion pressures) compared to empty enclosures because of increased flame surface area, enhanced turbulence in the wakes and obstructed vent openings, resulting in a decreased venting efficiency. NFPA68 does consider internal obstructions, and increasing surface area of all internal obstructions increases the required vent area significantly. In the report “Vented hydrogen deflagrations in containers: Effect of congestion for homogeneous and inhomogeneous mixtures” (https://h2tools.org/sites/default/files/2019-09/223.pdf) 66 explosion tests in a 20ft container were

conducted with Hydrogen / Air mixtures with varying levels of Hydrogen content of up to 42% (stoichiometric concentration is about 29.6%) and congestion. The study arrives at the conclusion that NFPA68 generally over-predicts the Pred values. A subsequent study suggests a venting correlation that includes a term for internal obstructions (Aobs) which gives lower Pred values compared to NFPA68. This confirms that the NFPA68 correlation and the treatment of the internal obstructions over-predicts Pred values in general and is thus a viable option for BESS applications. As with any other engineered system, basic principles (such as avoiding obstructed panel openings) have to be met to ensure an effective system.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 289-NFPA 855-2024 [Section No. 9.6.6.6.1.1]	
Public Comment No. 292-NFPA 855-2024 [Section No. 9.6.6.6.3]	
Public Comment No. 293-NFPA 855-2024 [Section No. 9.6.6.6.5]	
Public Comment No. 294-NFPA 855-2024 [Section No. A.9.6.6.6.3]	

Related Item

- FR-109

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Public Comment No. 289-NFPA 855-2024 [Section No. 9.6.6.6.1.1]

9.6.6.6.1.1

Explosion prevention and deflagration venting shall not be required based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study submitted to the AHJ for review and approval that demonstrates that flammable gas concentrations cannot accumulate and exceed, on average, 25 percent of the LFL.

Statement of Problem and Substantiation for Public Comment

Based on the public comment PC-278 for 9.6.6.6.1 and the problem statement and substantiation given there, deflagration venting should be added to this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 278-NFPA 855-2024 [Section No. 9.6.6.6.1 [Excluding any Sub-Sections]]	
Public Comment No. 292-NFPA 855-2024 [Section No. 9.6.6.6.3]	
Public Comment No. 293-NFPA 855-2024 [Section No. 9.6.6.6.5]	
Public Comment No. 294-NFPA 855-2024 [Section No. A.9.6.6.6.3]	

Related Item

- FR-109

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Public Comment No. 37-NFPA 855-2024 [Section No. 9.6.6.6.1.1]

9.6.6.6.1.1

Explosion prevention shall not be required based on fire and explosion testing in accordance with 9.1.5 and a deflagration hazard study submitted to the AHJ for review and approval that demonstrates that flammable gas concentrations cannot accumulate and ~~exceed, on average, 25 percent~~ exceed 25 percent of the LFL.

Statement of Problem and Substantiation for Public Comment

"Average" should be removed or better defined as to what the LFL is averaged over, for example time or volume. As LFL is already a volume-based percentage, it is not clear that further averaging is needed.

Related Item

- FR-109

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Public Comment No. 167-NFPA 855-2024 [Section No. 9.6.6.6.1.2]

9.6.6.6.1.2

Explosion control following this standard shall not be ~~required for the following:Lead~~ required lead -acid and ~~Ni-Cd battery systems less than 50 V ac, 60 V dc in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76Lead-acid and Ni-Cd battery systems that are and used for dc power~~ nickel-cadmium batteries where used in a stationary standby service where ventilation is provided per IEEE 1635/ASHRAE 21 and the application is consistent with any of the following:

(1) Comprised of vented cells in systems 600 V dc or less

(2) Comprised of cells listed to UL1973 in systems 600 V dc or less

(3) Used for control of substations and control or safe shutdown of generating stations under the exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations

~~that complies with the~~ ~~*National Electric Safety Code*~~ ~~or follows the guidelines of IEEE 1635/ASHRAE 21~~

(4) ~~Lead-acid battery systems in uninterruptible power supplies listed and labeled in accordance with the application used for standby power applications and housed in a single cabinet in a single fire area in buildings or walk-in units that follow the guidelines of IEEE 1635/ASHRAE 21~~

~~Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 that do not go into thermal runaway or produce flammable gas in the UL 9540A cell-level test or equivalent test~~

(5)

(6) Used for control of fixed guideway transit or passenger rail systems under the exclusive control of a transit authority and located outdoors or in building spaces used exclusively for such installations

(7) Are less than 60 V dc that are in telecommunications facilities for installations of communications equipment under the exclusive control of communications utilities and located outdoors or in building spaces used exclusively for such installations that are in compliance with NFPA 76

(8) Utilized in uninterruptible power supplies listed to UL 1778, which occupy no more than 10 percent of the floor area on the floor on which they are located.

Statement of Problem and Substantiation for Public Comment

TG 24 Recommendation to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as a listed products, and add rail transit control exemption similar to telecom and electric utility.

Suggested simplifications are welcomed.

Related Item

- TG 24

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Public Comment No. 198-NFPA 855-2024 [Section No. 9.6.6.6.1.3]

9.6.6.6.1.3

Explosion ~~prevention or deflagration venting analysis and~~ prevention and design shall be based upon the gas composition and volume identified by fire and explosion testing conducted in accordance with 9.1.5.

Statement of Problem and Substantiation for Public Comment

As NFPA 68 is being removed as a standalone requirement deflagration venting should be remove in favor of the simple statement - exposition prevention.

Related Item

- FR 109

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Public Comment No. 199-NFPA 855-2024 [Section No. 9.6.6.6.3]

9.6.6.6.3*

All ESSs shall be provided with a reliable explosion prevention system designed, installed, operated, maintained, and tested in accordance with NFPA 69.

<u>1. The NFPA 69 evaluation shall also include a partial volume deflagration evaluation per NFPA 68.</u>

Statement of Problem and Substantiation for Public Comment

Since a NFPA 69 system cannot remove all possible pockets of combustible gas, an NFPA 68 evluation should be performed to determine any potential risk associated with a partial volume deflagration.

Related Item

- FR 109

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Public Comment No. 266-NFPA 855-2024 [Section No. 9.6.6.6.3]

9.6.6.6.3*

All ESSs shall be provided with a reliable active explosion prevention system designed, installed, operated, maintained, and tested in accordance with NFPA 69 as well a passive explosion protection system in accordance with NPFA 68 .

Statement of Problem and Substantiation for Public Comment

To safely protect against explosions caused by gas releases from thermal runaway, NFPA 855 shall require that any ESS system installing an NFPA 69 active ventilation system shall also install an NFPA 68 passive solution as a secondary explosion protection method. The NFPA 68 solution should use the actual gas composition in its calculations as a secondary explosion protection method.

Details:

Concerns with NFPA 69 as a standalone solution:
Recent premature changes made to the first draft of NFPA 855 attempt to discredit the need for NFPA 68 (passive deflagration panels) by essentially forcing ESS manufacturers into two explosion protection options: Require an NFPA 69 (active ventilation system) or require the manufacturer to undergo a performance based solution, which is commonly a spark system used in conjunction with NFPA 68 deflagration panels.

Also, the verbiage in new recent annex draft of NFPA 855 would require manufacturers who want to use NFPA 68 panels in conjunction with NFPA 69 ventilation system to undergo a full-scale testing, which makes no sense. Is NFPA 855 really trying to claim that adding deflagration panels to an NFPA 69 system makes the ESS less safe or requires additional testing? This is a backwards message to send to the industry and we have not seen any data or real-world events to justify this.

Due to these premature draft changes and the message it is already sending to the industry, some ESS manufacturers are starting to implement ESS with only NFPA 69 ventilation systems or a performance based design.

An ESS implemented with only an NFPA 69 system requires the flammable concentration be maintained at or below 25 percent of the LFL for all foreseeable variations in all operating conditions. There are MANY uncertainties, risks, potential issues, and unrealistic inspection requirements with using an NFPA 69 system in an ESS:

1) NFPA 69 ventilation systems rely on many critical components to operate on time including detectors, fans, controllers, electrical/wiring, filters, louvers, battery backup, etc. Many BESS systems are never even tested in the field. BESS are typically designed to be in the field for over 20 years which makes for a high probability some of these NFPA 69 components will fail over time without the site knowing.

2) The design basis for an NFPA 69 ventilation system is determined from UL 9540A test data which clearly does not bind all scenarios and therefore additional failure modes are likely present in the field.

3) Activation of the NFPA 69 ventilation system requires detection and there is typically some delay associated with detection and ramp to full capacity before the 25% threshold is reached. The deflagration hazard is present during this delay.

4) Section 15.7.1 of NFPA 69 requires that every NFPA 69 system be thoroughly inspected every single quarter for the life of the ESS. This requirement has been a part of NFPA 69 for many years

due to the high number of potential issues that can go wrong with NFPA 69 active systems. It is unrealistic to expect that most ESS sites will have the capability or willingness to properly inspect every NFPA 69 system every quarter for the life of each ESS onsite. Failure to perform quarterly inspections means the ESS no longer meets NFPA 855 and more importantly makes the system more prone to issues or failure.
The below article provides some insight on the lack of inspections happening on various BESS systems:

A report made by CEA "Clean Energy Associates" from February 2024 states:

“The Past Several Years Have Shown that Thermal Runaway Poses a Significant Risk to the Energy Storage Industry. CEA has carried out more than 320 inspections around the world and identified over 1300 total manufacturing issues. 26% of inspected energy storage systems had quality issues related to the fire detection and suppression system and 18% of inspected systems had quality issues related to the thermal management system”. - Errors made by trained personnel.

5) Uncertainty in failure event duration adds complexity to the required backup power of an NFPA 69 ventilation system , its duration, and the reliability.

6) A premature move of relying only on NFPA 69 ventilation systems is likely to create challenges as ESS technology is evolving. Larger cells are being developed for ESS and these are expected to release a correspondingly higher amount of flammable gas. A “first cell” thermal runaway usuallyoccurs before the NFPA 69 exhaust ventilation system is activated.

The above issues show that only using an NFPA 69 solution can provide a false sense of safety in a BESS. It is important that ESS systems that have an NFPA 69 system also have a backup passive solution that complies with NFPA 68 which are reliable, have far fewer failure risks, are cost effective, require very little maintenance, and do not require costly quarterly inspection contracts that are rarely properly fulfilled and put the system at jeopardy.

Design per NFPA 68 calculations:
Usage of realistic explosion cloud: Currently, the NFPA 68 calculations are performed using a stoichiometric cloud making those overly conservative. An analysis showing the dispersion of real heterogeneous* clouds and using that information to quantify the hazards results in a credible definition of the scenario.
*7.2.3.2 (NFPA 68 2023)
The burning velocity, Su, shall be the maximum value for any gas concentration unless a documented hazard analysis shows that there is not a sufficient amount of gas to develop such a concentration.

Therefore, when it comes to defining venting surfaces, NFPA 68 equations should be applied by considering values established by thermal runaway tests and reports. By considering the actual values of burning velocity (SU), gas density (pu), specific heat ratio, Pmax, and gas viscosity, we obtain discharge surface values that correlate with the realities of potential thermal runaway events, not an unrealistic stoichiometric cloud.

Related Item

- • Passive solution/NFPA68/Deflagration Panel/Active + Passive

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Public Comment No. 292-NFPA 855-2024 [Section No. 9.6.6.6.3]

9.6.6.6.3*

All ESSs shall be provided with a reliable explosion prevention system designed, installed, operated, maintained, and tested in accordance with NFPA 69 and deflagration venting installed and maintained in accordance with NFPA68 .

Statement of Problem and Substantiation for Public Comment

Based on the public comment PC-278 for 9.6.6.6.1 and the problem statement and substantiation given there, deflagration venting should be added to this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 278-NFPA 855-2024 [Section No. 9.6.6.6.1 [Excluding any Sub-Sections]]	
Public Comment No. 289-NFPA 855-2024 [Section No. 9.6.6.6.1.1]	
Public Comment No. 293-NFPA 855-2024 [Section No. 9.6.6.6.5]	
Public Comment No. 294-NFPA 855-2024 [Section No. A.9.6.6.6.3]	

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name: Andreas Brandl
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Submittal Date: Thu May 30 12:34:19 EDT 2024
Committee: ESS-AAA

Public Comment No. 38-NFPA 855-2024 [Section No. 9.6.6.6.3]

9.6.6.6.3*

~~All ESSs~~ ESSs that require explosion control shall be provided with ~~a~~ reliable explosion prevention ~~system~~ systems designed, installed, operated, maintained, and tested in accordance with NFPA 69.

Statement of Problem and Substantiation for Public Comment

The current wording states ALL ESS shall have explosion control which conflicts with the numerous exemptions in the standard. The specific requirements for reliable explosion control design and use should be limited to only those ESS that need explosion control.

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name:	Richard Kluge
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Submittal Date:	Thu Mar 14 11:21:41 EDT 2024
Committee:	ESS-AAA

Public Comment No. 201-NFPA 855-2024 [Section No. 9.6.6.6.4]

9.6.6.6.4*

Independent ~~BESS~~ ESS cabinets installed in larger ~~BESS~~ ESS configurations such as rooms, buildings, or containers shall be designed so explosive discharge of gases or projectiles are not ejected during fire and explosion testing complying with 9.1.5, including the ESS cabinets and the space they are installed in.

Statement of Problem and Substantiation for Public Comment

Editorial for consistence of terms.

Related Item

- FR 109

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Mon May 27 14:46:32 EDT 2024
Committee: ESS-AAA

Public Comment No. 293-NFPA 855-2024 [Section No. 9.6.6.6.5]

9.6.6.6.5*

Where approved, ESSs designed to ensure that no hazardous pressure waves, debris, shrapnel, or enclosure pieces are ejected, as validated by installation-level fire and explosion testing and an engineering evaluation performed by a registered design professional complying with 9.1.5 that includes the cabinet, shall be permitted in lieu of providing explosion control that complies with NFPA 69. Explosion prevention according to NFPA 69 or deflagration venting according to NFPA 68 shall be permitted as a singular approved method when verified by installation level explosion testing and when approved by the AHJ.

Statement of Problem and Substantiation for Public Comment

Based on the public comment PC-278 for 9.6.6.6.1 and the problem statement and substantiation given there, deflagration venting should be added to this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 278-NFPA 855-2024 [Section No. 9.6.6.6.1 [Excluding any Sub-Sections]]	
Public Comment No. 289-NFPA 855-2024 [Section No. 9.6.6.6.1.1]	
Public Comment No. 292-NFPA 855-2024 [Section No. 9.6.6.6.3]	
Public Comment No. 294-NFPA 855-2024 [Section No. A.9.6.6.6.3]	

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name: Andreas Brandl
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Submittal Date: Thu May 30 12:42:09 EDT 2024
Committee: ESS-AAA

Public Comment No. 202-NFPA 855-2024 [Section No. 9.6.6.6.6 [Excluding any Sub-Sections]]

Where gas detection is used to activate a combustible gas concentration reduction system (CGCRS) and based on an NFPA 69 deflagration study, enclosures containing ESSs shall be protected by ~~an approved~~ a reliable and listed continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the CGCRS on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual flammable components.

(2) The CGCRS shall remain on to ensure the flammable gas does not accumulate and exceed 25 percent on average of the LFL of the gas mixture or of the individual flammable components.

(3) ~~When a gas detection system and CGCRS is installed, it shall be provided with the same secondary power requirements as the fire detection system.~~

~~For lithium-ion batteries, the CGCRS and activation system shall be provided with a minimum of 24 hours of power while in a nonalarm condition and 2 hours of power in an alarm condition.~~

(4) CGCRS and its components shall be considered a critical safety system and shall comply with section 4.10.

(5) The gas detection system and CGCRS status shall annunciate the

~~following~~

(6) status at a supervising

~~station as required by the AHJ to provide situation information~~

(7) station in accordance with *NFPA 72*

~~, or at an approved constantly attended location:~~

(8) ~~A trouble signal upon failure of the gas detection system or CGCRS~~

(9) ~~An alarm signal if flammable gas concentration exceeds 10 percent of the LFL~~

(10) .

Statement of Problem and Substantiation for Public Comment

Changes to the CGCRS required better consitance and requirement the terms and tie backs.

Related Item

- FR 109

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Mon May 27 14:50:01 EDT 2024

Committee: ESS-AAA

Public Comment No. 334-NFPA 855-2024 [Section No. 9.6.6.6.6 [Excluding any Sub-Sections]]

Where gas detection is used to activate a combustible gas concentration reduction system (CGCRS) and based on an NFPA 69 deflagration study, enclosures containing ESSs shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the CGCRS on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.

(2) The CGCRS shall remain on to ensure the flammable gas does not exceed 25 percent on average of the LFL of the gas mixture or of the individual components.

(3) When a gas detection system and CGCRS is installed, it shall be provided with the same secondary power requirements as the fire detection system.

(4) For lithium-ion batteries, the CGCRS and activation system shall be provided with a minimum of 24 hours of power while in a nonalarm condition and 2 hours of power in an alarm condition, or as required by the HMA .

(5) The gas detection system and CGCRS status shall annunciate the following at a supervising station as required by the AHJ to provide situation information in accordance with *NFPA 72*, or at an approved constantly attended location:

    (6) A trouble signal upon failure of the gas detection system or CGCRS

    (7) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL

Statement of Problem and Substantiation for Public Comment

We hold the same concern and view as Chris Groves of Wartsila “Some of these sites can be astronomically huge and it is not feasible to connect every fan of every enclosure to a backup generator power providing a RUN time of 2 hrs. It should be sized based on a competent FPE/Risk analysis to consider the maximum number of systems in alarm.”

Consider an average site with 200 separate BESS enclosures spread across 10 acres, each with it’s own ventilation system. It is unrealistic that every gas ventilation fan would be called on simultaneously.

Given that the HMA, which has been created and stamped by a licensed FPE, would account for appropriate separation distances and other safety factors, it would account for the necessary percentage of enclosures that would be at risk at one time.

Related Item

- PI #104

Submitter Information Verification

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Submittal Date: Thu May 30 16:12:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 39-NFPA 855-2024 [Section No. 9.6.6.6.6 [Excluding any Sub-Sections]]

Where gas detection is used to activate a combustible gas concentration reduction system (CGCRS) and based on an NFPA 69 deflagration study, enclosures containing ESSs shall be protected by an approved continuous gas detection system that complies with the following:

(1) The gas detection system shall be designed to activate the CGCRS on detection of flammable gases at no more than 10 percent of the LFL of the gas mixture or of the individual components.

(2) The CGCRS shall remain on to ensure the flammable gas does not exceed ~~25 percent on average of~~ 25 percent of the LFL of the gas mixture or of the individual components.

(3) When a gas detection system and CGCRS ~~is~~ are installed, ~~it~~ they shall be ~~provided with the~~ conform to the same secondary power requirements as the fire detection system.

(4) For lithium-ion batteries, the CGCRS and activation ~~system~~ systems shall be provided with a minimum of 24 hours of power while in a nonalarm condition and 2 hours of power in an alarm condition.

(5) The gas detection system and CGCRS status shall annunciate the following at a supervising station as required by the AHJ to provide situation information in accordance with *NFPA 72*, or at an approved constantly attended location:

  (6) A trouble signal upon failure of the gas detection system or CGCRS

  (7) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL

Statement of Problem and Substantiation for Public Comment

Average LFL is not well defined. Other changes are grammatical.

Related Item

- FR-109

Submitter Information Verification

Submitter Full Name: Richard Kluge
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Zip:
Submittal Date: Thu Mar 14 11:47:34 EDT 2024
Committee: ESS-AAA

Public Comment No. 230-NFPA 855-2024 [New Section after 9.6.6.6.6.2]

9.6.6.6.6.2.1

Where multiple battery cabinets or enclosures are tied to a single inverter or Control container the loss of one battery cabinets and enclousres shall not impair the operation or communication requirements of the other compartments.

A 9.6.6.6.2.1 Both Power and 72 compliant communications should provide alternate paths in the event of the loss of one path.

Statement of Problem and Substantiation for Public Comment

Multiple smaller containers, while they lower the risk of a larger failure event, loss of an upstream container impairs the visibility of possible impacts to downstream containers if the units do not have redundant path ways.

Related Item

- FR 109

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Tue May 28 16:37:17 EDT 2024
Committee: ESS-AAA

Public Comment No. 229-NFPA 855-2024 [Section No. 9.6.6.6.6.2]

9.6.6.6.6.2*

The HMA shall include an analysis to ensure survivability of the CGCRS up until fire occurs.

A 9.6.6.6.6.2 As an example, the fans for the CGCRS should meet the **r** equirement-ANSI/AMCA 210-ANSI/ASHRAE 51.- Additionally during a large scale test the CGCRS is required to be monitored for system failure points. This will support appropriate evaluation of survivability .

Statement of Problem and Substantiation for Public Comment

Currently CGCRS system don't have a listing requirement. Tying the fans back to a standard and well as testing will help support the concept of survivability and reliability.

Related Item

- FR 109

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Tue May 28 16:25:34 EDT 2024
Committee: ESS-AAA

Public Comment No. 232-NFPA 855-2024 [New Section after 9.6.6.6.6.3]

9.6.6.6.6.4 CGCRS shall be installed to the requirements of NFPA 69 chapter 15.5

Statement of Problem and Substantiation for Public Comment

NFPA 69 has specific requirements for installation of a CGCRS, while implicit, this confirms that installation requirements shall conform to NFPA 69

Related Item

- FR 109

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Tue May 28 16:45:38 EDT 2024
Committee: ESS-AAA

Public Comment No. 231-NFPA 855-2024 [Section No. 9.6.6.6.6.3]

9.6.6.6.6.3 CGCRS Performance.

(A)

Where suppression systems other than water based are contained within an ESS, the detection, logic solvers, and sequence of events for discharge shall not impede the CGCRS performance.

(B)

An analysis of no impact shall be provided to the AHJ along with performance data.

(C)

The dampers or Vents of the CGCRS shall fail in an open position on loss of power.

Statement of Problem and Substantiation for Public Comment

As CGCRS are complicated systems, they need a fail safe by requiring the air path way to open on a loss of power, allowing for combustible gas to escape.

Related Item

- FR 109

Submitter Information Verification

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Submittal Date: Tue May 28 16:41:41 EDT 2024
Committee: ESS-AAA

Public Comment No. 233-NFPA 855-2024 [Section No. 9.6.6.6.6.4]

9.6.6.6.6.~~4~~ 5

CGCRS shall meet the test and inspection requirements of Chapter 15 of NFPA 69.

(1) Per chapter 15.6 , Airflow test shall be run during commissioning to confirm that installed conditions can meet or exceed the NFPA 69 required airflows.

(2) Per chapter 15.7, the CSRCG airflow shall be tested to confirm the CGCRS systems are still functioning as designed.

(3) Testing shall be conducted and certified under the direction of an RDP.

Statement of Problem and Substantiation for Public Comment

NFPA 69 doesn't explicitly state that air flow test must be run to confirm actual conditions vs design conditions. Additional NFPA 69 doesn't explicitly state that air flow volume must be checked during inspections. This provide clarification that it is required and must be supervised by appropriate licensed personnel.

Related Item

- FR 109

Submitter Information Verification

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Submittal Date: Tue May 28 16:48:07 EDT 2024
Committee: ESS-AAA

Public Comment No. 215-NFPA 855-2024 [Section No. 9.6.6.6.8]

9.6.6.6.8

The protection design shall demonstrate that ~~deflagrations are not propagated~~ flammable gases do not migrate to interconnected ~~BESSs~~ ESSs .

Statement of Problem and Substantiation for Public Comment

Statement of deflagration not propagating to adjacent units is not clear, the original intent was to limit combustible gas between interconnects.
Editorial consistence using ESS.

Related Item

- PI 78

Submitter Information Verification

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Submittal Date: Tue May 28 10:00:23 EDT 2024
Committee: ESS-AAA

Public Comment No. 241-NFPA 855-2024 [New Section after 9.6.7]

9.6.7* Abnormal Toxic and highly toxic emission detection

Statement of Problem and Substantiation for Public Comment

Committee input on toxic CI 104, 106 requested input on adding Toxics to the tables. TG 6 has provided guidance to Toxics and first responders in the Annex. As such no new toxic section has been add and modifications to the tables are not required.

Related Item

- CI 106

Submitter Information Verification

Submitter Full Name: Paul Hayes
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City:
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Zip:
Submittal Date: Wed May 29 09:58:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 74-NFPA 855-2024 [New Section after 9.6.7]

Commentary on CI-106

Statement of Problem and Substantiation for Public Comment

Some good content, but this seems rather vague for a minimum installation standard. It might be warranted in some cases and for that reason I suggest move it to the annex.

Related Item

- CI-106

Submitter Information Verification

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Submittal Date:	Thu Mar 21 17:54:45 EDT 2024
Committee:	ESS-AAA

Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]

FESS installations shall comply with the requirements of Chapters 4 through 8, except as specified in Table 13.2.

Table 13.2 FESS Technology-Specific Requirements

Compliance Required	**Applies**	**Reference**		
Construction documents	Yes	4.2.1.1 except as modified in 13.2.1 and 13.2.2		
	-	No	4.2.1.2	-
	No	4.2.1.3		
	-	No	4.2.1.4	
Emergency planning and training	Yes	4.3.2.1.4 applies except as noted in 13.2.2		
	-	No	4.3.2.1.5	
Hazard mitigation analysis (HMA)	Yes	4.4.1 applies except as noted in 13.2.3		
Fire and explosion testing	No	9.1.5		
Equipment	Yes	Section 4.6		
Retrofits	Yes	Except 4.6.3.2 and 4.6.3.3		
Environment	Yes	4.6.7		
Charge controllers	No	4.6.8		
Energy storage management systems	Yes	4.6.10		
Reused equipment	No	4.6.5		
Seismic protection	Yes	4.7.2		
Fire barriers	No	9.6.4		
Elevation	No	4.7.7		
Open rack installation	No	4.7.9		
ESS dedicated-use buildings	No	9.3.1.1		
Non-dedicated-use buildings	No	9.3.1.2		
Outdoor installations	No	9.3.2		
Enclosures	Yes	4.6.12		
Rooftop and open parking garage installations	No	9.5.3.1 except as noted in 13.2.7, 13.2.7.1, and 13.2.7.2		
Mobile ESS equipment and operations	Yes	9.5.3.2		
	-	No	9.5.3.2.1.2	-
	No	9.5.3.2.2.2		
	-	No	9.5.3.2.5.3	
	-	No	9.5.3.2.6	
Size and separation	No	9.4.2		
~~Maximum stored energy~~	~~No~~	~~9.4.1~~		
Exhaust ventilation	No	9.6.5.1		
Smoke and fire detection	No	Section 4.8		
Fire control and suppression	No	Section 4.9		
Explosion control	No	9.6.5.6		
Water supply	No	4.9.4		
System interconnection	Yes	Chapter 5		
Commissioning	Yes	Chapter 6		

Compliance Required	Applies	Reference
Operation and maintenance	Yes	Chapter 7
-	No	7.1.3
Decommissioning	Yes	Chapter 8

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]	
Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]	
Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]	
Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]	
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	
Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]	
Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]	

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name: Robert Davidson
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Submittal Date: Thu May 30 13:25:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 114-NFPA 855-2024 [Section No. 14.1 [Excluding any Sub-Sections]]

> Areas associated with the collection or storage of lithium metal or lithium~~-ion batteries shall~~ ion batteries, used in stationary ESSs, shall comply with this chapter.

Statement of Problem and Substantiation for Public Comment

the applicability of Chapter 14 seems to imply that it applies to the collection or storage of ALL lithium metal or lithium-ion batteries. The proposed change is intended to help clarify that the scope of chapter 14 only applies to lithium metal or lithium-ion batteries used in stationary ESSs. this proposed change also helps with alignment with the scope of the entire standard.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 113-NFPA 855-2024 [Section No. 1.1]	scope

Related Item

- chapter 14 scope

Submitter Information Verification

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Submittal Date: Mon May 20 10:25:46 EDT 2024
Committee: ESS-AAA

Public Comment No. 24-NFPA 855-2024 [Section No. 14.1.1]

14.1.1

The following areas shall be exempt from the requirements of this chapter:

(1) Areas within a facility that are operated in accordance with procedures that provide for the state of charge of the lithium metal or lithium-ion batteries to be 30 percent or less

(2) Areas where fire and fault condition testing conducted or witnessed and reported by an approved testing laboratory is provided showing that a fire involving the batteries in storage will be limited to the design area of an automatic sprinkler system installed in accordance with NFPA 13 and will not adversely impact occupant egress from the building or adversely impact adjacent stored materials or the building structure

(3) Areas where new or refurbished batteries are installed for use in the devices, equipment, or vehicles they are designed to power

(4) Areas where new or refurbished batteries are packed for use with the devices, equipment, or vehicles they are designed to power

(5) Areas where new or refurbished batteries rated at no more than 300 Watt-hours (1.08 MJ) and lithium metal batteries containing no more than 25 g of lithium metal are in their original retail packaging

(6) Areas where batteries are staged in the manufacturing area or along assembly lines during the manufacturing process

(7) <u>Areas where batteries used for material handling are staged for recharging and swap out of batteries on material handling equipment.</u>

Statement of Problem and Substantiation for Public Comment

In 14.1.1 where it states exemptions Item 6 is somewhat vague and I presume it is assembly of lithium batteries or lithium batteries assembled into some other final assembly. There is nothing that addresses lithium batteries being used in Motive power applications, such as material handling. Many manufacturing and warehouses facilities, have specific charging areas that they stage batteries to recharge and then swap back into material handling equipment.

<u>Related Item</u>

- NFPA 855 2026 first draft

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Submittal Date: Wed Mar 13 11:13:07 EDT 2024
Committee: ESS-AAA

Public Comment No. 312-NFPA 855-2024 [Section No. 14.4]

14.4 Prevention and Mitigation.

14.4.1

A plan that provides for the prevention of fire incidents and includes early detection mitigation measures shall be provided to the AHJ for review and approval.

14.4.2

The mitigation plan shall include an approved method for containment of projectiles from cells involved in thermal runaway.

<u>14.4.3*</u>

<u>The mitigation plan shall include an approved method for post incident stablization, including proper mitigation of affected cells, batteries, and modules.</u>

<u>A 14.4.3</u>

<u>A mitigation plan is critical in the management of an emergency of a battery from early detection, actions during an incident and after a thermal event. Inclusion of proper fire watch, handling, post incident stablization and after incident actions are key. The plan should include appropriate resources for packaging, transport and handling of a damanged cell, module, or battery after an incident.</u>

Statement of Problem and Substantiation for Public Comment

This proposal adds to the public input on the mitigation efforts specific to batteries utilized in the non-ess space. The mitigation plan should not only include the aspect of early detection and response profile, the need for proper post incident de-esclation and handling of products that were exposed to a thermal event, or affected by water is key. This proposal adds a clarification that the plan should include post incident procedures as well as appendix clarification on contents.

<u>Related Item</u>

- FR-166

Submitter Information Verification

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Submittal Date: Thu May 30 14:12:19 EDT 2024
Committee: ESS-AAA

Public Comment No. 306-NFPA 855-2024 [Section No. 15.1]

15.1* General.

ESS installations with a rating of 1 kWh (3.6 MJ) or greater and associated with one- or two-family dwellings or townhouse units shall comply with the requirements of this chapter.

15.1.1 Flywheel Energy Storage Systems (FESSs) shall be installed in accordance with Chapter 13.

Statement of Problem and Substantiation for Public Comment

Chapter 13 Flywheel Energy Storage Systems (FESSs) has been modified to clarify that FESSs can be installed at detached one- and two-family homes and townhouse, the added section points to the user of NFPA 855 to Chapter 13 for the requirements applicable to FESSs.

Related Item

- FR-26

Submitter Information Verification

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Submittal Date: Thu May 30 13:46:49 EDT 2024
Committee: ESS-AAA

Public Comment No. 214-NFPA 855-2024 [Section No. 15.2]

15.2 Equipment Listings.

15.2.1

ESSs shall be listed and labeled in accordance with UL 9540.

15.2.2

Lead-acid and nickel-cadmium batteries <u>comprised of vented cells or cells listed to UL 1973</u> used in residential energy storage systems ~~and listed to UL 1973~~ shall not require UL <u>9540 listing or additional UL</u> 9540A testing where they comply with one or more of the following:

(1) They are installed with a charging system that is listed to UL 1012, UL 60950-1, or UL 62368-1.

(2) The inverter is listed to UL 1741.

(3) The UPS is listed to UL 1778.

Statement of Problem and Substantiation for Public Comment

Recommendation of TG 24 to make lead-acid and nickel cadmium exemptions more consistent, not to exclude vented lead-acid and nickel-cadmium, which have not been available as listed products.

<u>Related Item</u>

- TG 24

Submitter Information Verification

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Submittal Date:	Tue May 28 09:58:52 EDT 2024
Committee:	ESS-AAA

Public Comment No. 267-NFPA 855-2024 [Section No. 15.3.1]

15.3.1 ESS Spacing.

Individual ESS units shall be separated from each other by a minimum of 3 ft (0.9 m) unless smaller separation distances are documented ~~to be adequate based on fire and explosion testing complying with Section 15.13 .~~ by the manufacturers installation instructions in accordance with the product's UL9540 listing.

Statement of Problem and Substantiation for Public Comment

The reference to UL 9540 has been updated to the 2023 Edition of UL 9540. UL 9540:2023 incorporates UL 9540A as a required test method to justify < 3' unit spacing in the manufacturers installation instructions. Paragraph 15.12 still requires manufacturers to provide a product level evaluation report,

Less than three foot unit to unit spacing results in increased interior installations, reducing exterior requirements based on performance based testing and promotes greater utilization of exterior space for ESS installations.

In a separate Public Comment we are proposing to strike Paragraphs 15.13 and 15.13A, as a companion change to this Public Comment.

Related Item

- FR101
- PI 29
- PI 30

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 269-NFPA 855-2024 [Section No. 15.4.1]

15.4.1

ESSs shall only be installed in the following locations:

(1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code

(2) In detached garages and detached accessory structures

(3) Outdoors on exterior walls or on the ground located a minimum of 3 ft (914 mm) from doors and windows directly entering the dwelling unit unless smaller separation distances are documented in the manufacturers installation instructions in accordance with the product's UL 9540 listing.

(4) In enclosed utility closets and storage or utility spaces- ~~where approved by the AHJ~~ .

Statement of Problem and Substantiation for Public Comment

Outdoor installations present the lowest risk basis and should be provided with flexibility for increased favorable exterior placement where UL 9540A testing incorporated through UL 9540:2023 permits such reduced spacing to be evaluated by the listing NRTL. The 3' spacing found in other sections allows for performance based reductions from the prescriptive requirement.

The "where approved language" for utility closets and storage or utility spaces leads to enforcement issues due to lack of prescriptive requirements or guidance criteria to confirm suitability of enclosed utility closets and storage or utility spaces for ESS installation.
3' restrictions results in increased interior installations, reducing exterior requirements based on performance based testing promotes greater utilization of exterior space for ESS installations.

Related Item

• FR34 • PI157

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 283-NFPA 855-2024 [Section No. 15.4.1]

15.4.1

ESSs shall only be installed in the following locations:

(1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code

(2) In detached garages and detached accessory structures

(3) Outdoors on exterior walls or on the ground ~~located a minimum of 3 ft (914 mm) from doors and windows directly entering the dwelling unit~~

(4) In enclosed utility closets and storage or utility spaces where approved by the AHJ

<u>Exception:</u>

<u>1. ESS listed and labeled for use in habitable spaces.</u>

Statement of Problem and Substantiation for Public Comment

I agree with the original public input, the requirement for 3' spacing from doors and windows is likely to push more installations into garages and utility spaces, when outdoors is a safer location for many ESS chemistries. However, it is also important to add the exception (that mirrors the exception as found in IRC 2024 and in UL9540) for units tested and listed for use in habitable spaces. If there are ESS chemistries and module/unit designs that can be proven to be safe for indoor installations through rigorous testing per UL9540 and 9540A testing, then they should be acceptable anywhere in habitable space. The idea here is to be clear that hazardous chemistries and designs are safer outside, while safe chemistries and designs are allowed in habitable spaces if testing and listing clearly identifies those units.

I do not believe the resolution per the committee statement effectively addressed the original public input substantiation. I believe 3’ spacing between units is to limit fire spread, while the 3’ spacing from windows and doors is to limit toxic and flammable gas entering the dwelling. Those are two different reasons, and again I think the original submitter was correct in their statement that removing this window and door spacing requirement encourages more outdoor installations rather than indoor installations for chemistries and ESS designs that really should not be installed inside.

Related Item

- Public Input No. 157-NFPA 855-2023 [Section No. 15.4.1]

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Submittal Date: Thu May 30 09:00:56 EDT 2024

Committee: ESS-AAA

Public Comment No. 270-NFPA 855-2024 [Section No. 15.4.2]

15.4.2

If the ~~room or space where~~ enclosed utility closet and storage or utility space where the ESS is to be installed is not finished or has combustible walls or ceilings, the unfinished or combustible walls and ceilings of the room or space shall be protected with not less than ⅝ in. Type X gypsum board.

Statement of Problem and Substantiation for Public Comment

Paragraph 15.4.1.1 requires garages to have appropriate separation from the dwelling unit living area and sleeping units in accordance with the local building code. The requirements in Paragraph 15.4.2 should be intended for enclosed closets and storage or utility spaces, which may be located adjacent to sleeping and dwelling areas and requires minimum prescriptive requirements exceeding code permissible requirements for such spaces.

Related Item

• FR21 • PI175

Submitter Information Verification

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Public Comment No. 286-NFPA 855-2024 [Section No. 15.5]

15.5 Energy Ratings.

15.5.1

Individual ESS units using battery chemistries other than lead-acid, Ni-Cd, Ni-Zn, Ni-MH, or NaNiCl shall have a maximum ~~stored energy~~ rating of 20 kWh.

15.5.2 ~~Aggregate Rating.~~

~~**15.5.2.1**~~ –

~~The aggregate rating~~

The ratings of the ESS in each location shall not exceed the

~~following for each location listed:~~

(1) ~~40 kWh within utility closets, basements, and storage or utility spaces~~

(2) ~~80 kWh in attached or detached garages and detached accessory structures~~

(3) ~~80 kWh where outdoor wall mounted~~

(4) ~~80 kWh where outdoor ground mounted~~

~~15~~ ratings in Table 15.5.2.

[Table 15.5.2 in attached document]

15 .5.2. ~~2~~ – 1

Aggregate rating for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted.

15.5.3 – The total aggregate ratings of ESS on the property shall not exceed 600 kWh.

15.5.4

ESS installations exceeding the individual or aggregate ratings allowed by 15.5.1- ~~or~~ through 15.5. ~~2~~ 3 shall comply with Chapters 4 through 9.

15.5. ~~4~~ 5 * –

The use of an electric-powered vehicle to power the dwelling while parked shall comply with Section 15.11.

Additional Proposed Changes

File Name	Description	Approved
NFPA_855_PC_Increased_Aggregate_ratings_for_ESS_15.5.1.docx	Document containing proposed Table 15.5.2 Maximum Ratings of ESS	

Statement of Problem and Substantiation for Public Comment

The NFPA 855 TG34 Chapter 15 is proposing to accept the suggested changes from PI No. 342 as a necessary improvement to the permitted energy aggregates installed in detached one- and two-family dwellings and townhouses. The original aggregates were created with limited understanding of energy needs. Experience has shown that moderate to large sized homes require the ability to have increased storage levels. Though the aggregate amounts are proposed for increases, the core safety requirement of limiting individual units to 20 kWh is maintained.

The aggregate amounts were developed by a group that included industry and fire service members. The increased aggregates have been adopted by the State of California State Fire Marshal's Office.

Related Item

- Public Input No. 342-NFPA 855-2023

Submitter Information Verification

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Committee: ESS-AAA

NFPA 855, 2026 Edition

Public Input #342

Proponents:

NFPA 855 TG 34 Chapter 15

15.5 Energy Ratings.

15.5.1 Individual ESS units shall have a maximum ~~stored energy~~ rating of 20 kWh.

15.5.2 ~~The aggregate rating~~ ~~*of the ESS shall not exceed the following for each location listed:*~~ The ratings of the ESS in each location shall not exceed the ratings in Table 15.5.2.

~~1. 40 kWh within utility closets and storage or utility spaces.~~

~~2. 80 kWh in attached or detached garages and detached accessory structures.~~

~~3. 80 kWh on exterior walls.~~

~~4. 80 kWh outdoors on the ground.~~

Table 15.5.2 Maximum Ratings of ESS

Location	Maximum Ratings (kWh)	Installation Requirements
Within utility closets, basements, and storage or utility spaces located within dwellings	40	
In attached garages	100	
On or within 3 feet of exterior walls of dwellings and attached garages, or Outdoors on the ground	200	

In detached garages and detached accessory structures	200	
In detached garages and detached accessory structures	600	Detached garage or detached accessory structure is a minimum 10 feet away from property lines and dwellings.
Outdoors on the ground	600	ESS is a minimum 10 feet away from property lines and dwellings.

For SI: 1 foot = 304.8 mm

15.5.2.1 Aggregate rating for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted.

15.5.3 The total aggregate ratings of ESS on the property shall not exceed 600 kWh.

~~**15.5.3**~~ **15.5.4** ESS installations exceeding the individual or aggregate ratings allowed by 15.5.1 ~~or 15.5.2~~ through 15.5.3 shall comply with Chapters 4 through 9.

~~**15.5.4**~~**15.5.5** The use of an electric-powered vehicle to power the dwelling while parked shall comply with section 15.11.

Reason: The proposed changes to section 15.5 clarify the original intent for this section, which was to provide a maximum threshold for each location. It was not the intent to limit installations to one location on the property, or to limit to only 80 kWh for all ESS installed on the property. Providing the various maximum thresholds in tabular form provides an easier method for the code user to determine the limits for each location.

Within utility closets, basements and storage or utility spaces

The 40 kWh limit is unchanged from the current version of NFPA 855. That language clarifies that the 40 kWh limit does not apply to spaces or closets located within garages or accessory structures. It only applies to “within the dwelling.”

In attached garages

As the ESS industry has gained more experience with the needs of their customers and the grid, and the building safety community has gained more experience with ESS, it is becoming clear that the arbitrary capacity restrictions in the residential code are a hindrance to the deployment of clean energy technologies and are unneeded for safety. Hundreds of thousands of residential batteries have been installed and constructed to product standards leading to greater levels of safety. Taken together, these facts support a reasonable increase in kWh capacity to align with other anticipated hazards and fuel loads that may be present in a residential garage.

A modest increase in the allowable aggregate ESS capacity from 80 kWh to 100 kWh does not pose a significant elevated fire risk in the garage. Manufacturers design ESS to well-established safety standards. They have demonstrated proven track records of operating without igniting in homes, and are built in a way to resist adding fuel to fires from other sources. In the rare event of an ESS fire, a fire from 100 kWh of energy storage does not pose a significantly greater threat to occupant safety and is not significantly more difficult to extinguish than a fire from 80 kWh of energy storage.

The fuel energy density and heat release rate potential presented by a 100-kWh energy storage system are comparable to that of vehicles parked in garages. 100 kWh is a typical capacity of currently available electric vehicles (EVs), which use lithium-ion chemistries as do many stationary ESS. EVs also present significant additional fuel load through materials like upholstered seating and plastic trim. Internal combustion engine (ICE) vehicles have fuel, engine lubricants, and other components with the potential for very significant heat release rates. While the fuel load in a vehicle fueled by a gaseous fuel such as CNG or hydrogen can be less than that of a 100-kWh ESS in total energy output, the dynamics of a designed quick release of a gaseous fuel due to fire exposure in an attached garage can pose a significant concentrated fire exposure, or potentially a deflagration hazard risk to occupants and emergency responders.

This proposal allows homes to add an aggregate of 100 kWh of energy storage to an attached garage, while keeping the content fuel loads at safe levels. While actual fuel loads in garages can vary widely, this can be demonstrated using typical and conservative figures:

A reasonable fuel load for a garage is approximately 22,300 MJ. This assumes the garage is 20’ x 20’ and that a reasonable fuel load density is 600 MJ/m . Parking two gasoline powered cars in the garage makes up approximately 10,600 MJ of fuel load. Other garage items can make up approximately 3,300 MJ of fuel load. The remaining fuel load available to an ESS (22,300 MJ minus 10,600 MJ minus 3,300 MJ) is 8,400 MJ. 8,400 MJ is equivalent to an ESS with an aggregate capacity of 100 kWh, assuming the ESS has a fuel load of 84 MJ/kWh.

On or within 3 feet (914 mm) of exterior walls of dwellings and attached garages

ESS on the exterior side of exterior walls pose less of a safety risk than ESS inside attached garages. Typical exterior home construction provides sufficient protection from a thermal event. The product safety standard has specific requirements when ESS is intended for wall mounting, near exposures, where surface temperature measurements on wall surfaces do not exceed 97°C (175°F) of temperature rise above ambient per 9.2.15.

In detached garages and detached accessory structures

This scenario poses minimal risk to occupant safety, considering the distance from the dwelling and testing required of ESS. ESS in detached structures pose less of a safety risk than ESS on the exterior side of the dwelling. If an ESS with an aggregate rating of 200 kWh on the exterior side of the dwelling is considered reasonable, then an ESS with an aggregate rating of 200 kWh should be reasonable for ESS in detached structures. 600 kWh matches Table 1207.5 of the IFC. ESS in structures separated from the dwelling by 10 feet do not pose demonstrable risk to occupants.

Outdoors on the ground

This scenario poses minimal risk to occupant safety, considering the distance from the dwelling and the testing required of ESS. Ground mount ESS pose less of a safety risk than ESS on the exterior side of the dwelling. If an ESS with an aggregate rating of 200 kWh on the exterior side of the dwelling is considered reasonable, then an ESS with an aggregate rating of 200 kWh should be reasonable for ESS mounted on the ground.

Additionally, 200 kWh is equivalent to two typical EVs that can be parked anywhere on the property.

600 kWh matches Table 1207.5 of the IFC. ESS separated from property lines and the dwelling by 10 feet does not pose a demonstrable risk to occupants.

Endnotes

1. Tesla Model X has a capacity of 100 kWh. Tesla Model S has a capacity of 70-85 kWh. Chevy Bolt has a capacity of 66 kWh. The electric Ford F150 has a capacity of 110-130 kWh or 150-180 kWh with extended range. Sources: ttps://www.forbes.com/wheels/cars/tesla/model-x/, https://www.tesla.com/sites/default/files/tesla-model-s.pdf, https://media.chevrolet.com/media/us/en/chevrolet/vehicles/bolt-ev/2021.tab1.html, https://www.forbes.com/wheels/news/2022-ford-f-150-lightning-ev-pickup-debuts-300-mile-range-priced-at-40k.

2. Builders’ websites show the typical two-garage is around 20' x 20'. For example, HWS Garages' website states that "The average 2-car garage size is anywhere from 18’ x 20’ to 22′ x 22’.” While some garages are one-car and some are three-car, a poll conducted by Garage Living shows that 61 percent of garages are two-car. Sources: www.hwsgarage.com/average-garage-sizes/ and www.garageliving.com/blog/home-garage-stats.

3. The average fuel load of a living room is 600 MJ/m . 600 MJ/m^2 is also the business standard in NFPA 557. Sources: Alex Bwalya et al., "A Pilot Survey of Fire Loads in Canadian Homes," National Research Council Canada, March 9, 2004; National Fire Protection Association, "NFPA 557: Standard for Determination of Fire Loads for Use in Structural Fire Protection Design," 2020 Edition, Section 6.1.3.

4. 10,577 MJ (rounded to 10,600 MJ) assumes a small car (2,909 MJ) and large car (7,648 MJ). Sources: Mohd Tohir and Michael Spearpoint, "Distribution analysis of the fire severity

characteristics of single passenger road vehicles using heat release rate data," Fire Science Reviews, 2013. Also see M.J. Spearpoint, et. al., "Fire load energy densities for risk-based design of car parking buildings," Case Studies in Fire Safety, 29 April 2015.

5. 3,341 MJ (rounded to 3,300 MJ) is equivalent to half the fuel load items in a typical basement living room. Source: Bwalya, A.C., et. al., "Survey Results of Combustible Contents and Floor Areas in Multi-Family Dwellings," National Research Council Canada, 24 October 2008.

6. 84 MJ/kWh is derived from the estimated fuel load of the gases released by an ESS in thermal runaway (44 MJ/kWh) and the estimated fuel load of the burnable contents inside the ESS (40 MJ/kWh). 44 MJ/kWh was derived from reviewing several studies referenced below. 40 MJ/kWh was derived from multiplying 2 kg/kWh (a conservative figure for burnable contents inside the ESS – the weight of internal contents for some ESS is 1.0-1.5 kg/kWh) by 20 MJ/kg (the typical fuel load of a computer). Sources for fuel load of gases: Frederik Larsson, "Toxic fluoride gas emissions from lithium-ion battery fires," Scientific Reports, 30 August 2017; David Sturk et. al., “Fire Tests on E-vehicle Battery Cells and Packs,” Traffic Injury Prevention, 25 February 2015. Sources for kg/kWh weight of internal burnable contents: Tesla, SimpliPhi, and Solaredge. Source for fuel load of a computer: Alex Bwalya et al., "A Pilot Survey of Fire Loads in Canadian Homes," National Research Council Canada, March 9, 2004.

Cost Impact: The code change proposal will not increase or decrease the cost of construction It clarifies how the maximum thresholds are applied. Allows for more ESS while maintaining a level of safety.

Public Comment No. 271-NFPA 855-2024 [Section No. 15.5.2]

15.5.2 Aggregate Rating.

15.5.2.1

The aggregate rating of the ESS shall not exceed the following for each location listed:

(1) 40 kWh within utility closets, basements, and storage or utility spaces

(2) 80 kWh in each attached or detached ~~garages and~~ garage, and each detached accessory ~~structures~~ structure

(3) 80 kWh where outdoor wall mounted

(4) 80 kWh where outdoor ground mounted

15.5.2.2

Aggregate rating for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted.

Statement of Problem and Substantiation for Public Comment

Attached garages, detached garages and detached accessory structures do not contribute fuel load to other respective locations captured in this section. The intent is to limit fuel load for the permissible space which does not support an aggregate maximum for all locations falling into this bucket. The proposed changes clarify that the 80 kWh aggregate rating is for each individual attached or detached garage or detached accessory structure.

Related Item

- PI342

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Public Comment No. 272-NFPA 855-2024 [New Section after 15.7]

15.7.3 Where fire detection required by 15.7.1 or 15.7.2 is not feasible due to compatibility or access issues, fire detection shall be installed in the rooms where the ESS is located with interior annunciation provided in all of the following locations:

(1) Each level of the dwelling unit

(2) Immediately outside all sleeping areas.

Statement of Problem and Substantiation for Public Comment

The reality of interconnected fire detection devices is that devices from varying manufacturers cannot be interconnected per their listings. Residential structures may have specific brands of fire detection devices with no compatible heat alarms or detectors. The listing requires interconnection to compatible devices to ensure that communication protocol functions properly.

Contractors need the flexibility to comply with the intent of NFPA 855 where interconnection to existing systems or alarms is not feasible or practical.

Related Item

- PI345

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Public Comment No. 288-NFPA 855-2024 [New Section after 15.7]

15.7.3* Where the interconnection of smoke alarms or heat alarms required by Sections 15.7.1 and 15.7.2 is not feasable or practical, a fire detection system complying with NFPA 72 shall be installed.

A.15.7.3 The installation of NFPA 72 fire detection systems in lieu of interconnected smoke alarms or heat alarms is permitted by the building and fire codes and in larger homes is the only option. A benefit of apply NFPA 72 is the recognition of wireless interconnected devices.

Statement of Problem and Substantiation for Public Comment

The TG 34 Chapter 15 members are submitting this proposal to improve application of the requirement for fire detection. Installing an NFPA 72 systems is currently an option found within the applicable building and fire codes. Use of NFPA 72 is important for larger homes and where interconnecting smoke alarms and heat alarms is not feasible or practical. An added benefit is the NFPA 72 recognition of wireless systems.

Related Item

- Public Input No. 345-NFPA 855-2023

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Public Comment No. 273-NFPA 855-2024 [Section No. 15.8]

15.8* Protection from Vehicle Damage.

ESSs installed in a location subject to vehicle damage shall be protected by approved bollards, wheel barriers, or other approved barriers .

15.8.1 Inside Garages.

The following locations shall not be considered subject to vehicle damage:

(1) ESS installed on side walls of garages where the ESS does not protrude past the side wall into the vehicular driving path, as defined by the width of the garage door opening to the opposing garage wall.

(2) ESS installed above the potential impact height of 36 inches from grade

Statement of Problem and Substantiation for Public Comment

AHJs are routinely requiring 10,000 lb. impact-rated bollards due to lack of granularity in the prescriptive requirements. Such bollards are not feasible for residential applications. The gap for residential installations exceeds that of commercial installations complying with Ch. 4-9 of NFPA 855. Residential installations require that guidance not be placed in the informative annex; but rather, in the normative requirements of the standard.

Related Item

- FR168

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Public Comment No. 268-NFPA 855-2024 [Section No. 15.13]

~~**15.13**~~ – ~~Fire and Explosion Testing.~~

~~**15.13.1**~~ ~~*~~ –

~~Where required by 15.3.1 , fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standards.~~

~~**15.13.1.1**~~ –

~~The complete UL 9540A or equivalent test report shall be provided to the authority having jurisdiction, including the cell, module, and unit level.~~

~~**15.13.1.2**~~ –

~~Lead-acid and nickel-cadmium batteries used in standby power systems and listed to UL 1973 shall not require UL 9540A testing when installed with a charging system listed to UL 1012, UL 1741, CAN/CSA C22.2 No. 107.2, UL 60950-1, or UL 62368-1, or a UPS listed to UL 1778.~~

~~**15.13.1.3**~~ –

~~The testing shall be conducted, witnessed, and reported by an approved testing laboratory to characterize the composition of the gases generated and show that a fire involving one ESS unit will not propagate to an adjacent unit.~~

~~**15.13.1.4**~~ ~~*~~ –

~~The representative cell, modules, and units tested, including any optional integral fire suppression system, shall match the intended installation configuration other than the addition of the cell failure mechanism utilized for cell thermal runaway initiation.~~

~~**15.13.1.5**~~ –

~~The testing shall include evaluating deflagration mitigation measures when designed into ESS cabinets.~~

Statement of Problem and Substantiation for Public Comment

This is a companion change to Public Comment 268 that proposes to delete the reference to this section from Paragraph 15.3.2. See PC 268 for further justification for deleting this Section.

Related Item

- PC267
- PI30
- FR102

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Committee: ESS-AAA

Public Comment No. 95-NFPA 855-2024 [Section No. 15.13.1 [Excluding any Sub-Sections]]

> Where required by 15.3.1, fire and explosion testing shall be conducted on a representative ESS in accordance with UL 9540A ~~or equivalent test standards~~ and UL 9540B .

Statement of Problem and Substantiation for Public Comment

1. Removes "or equivalent test standards" for fire and explosion testing
2. Adds UL 9540B, Outline of Investigation for Large-Scale Fire Test for Battery Energy Storage Systems.

UL 9540B was developed to provide a standardized large-scale fire test method to evaluate the fire propagation characteristics of residential battery energy storage systems (BESS)

UL 9540A was established to evaluate the thermal runaway propagation behavior of battery energy storage systems that are capable of undergoing thermal runaway. It has been referenced in NFPA 855 as a "large-scale fire test" and "fire and explosion testing".

Because UL 9540A testing of residential BESS did not always lead to a fire condition within the residential BESS, this has led to the rejection of UL 9540A test reports from residential ESS manufacturers in some jurisdictions because the Authorities Having Jurisdiction were looking for a large-scale fire test as referenced in their local codes.

The single cell failure thermal runaway propagation test method of UL 9540A did not address the concerns of the fire service with regards to the following:
(1) an internal fire brought about by a thermal runaway propagation event involving multiple cells in a residential energy storage system and
(2) the spread of fire moving from one residential energy storage system unit to the next or to supporting structures

UL Solutions, with the input of representatives from the fire service in the California Bay Area, developed UL 9540B, Large-scale Fire Test for Residential Battery Energy Storage Systems, which is a test method to address the local fire code requirement for a large-scale fire test, and to establish a published test method that can be consistently applied to evaluate residential energy storage systems.

UL 9540B consists of a Cell Test, similar to UL 9540A, and a Fire Propagation Test that establishes a fire condition inside the residential BESS due to a thermal runaway propagation event.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 313-NFPA 855-2024 [Section No. A.15.13.1]	

Related Item

- FR-102

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Committee: ESS-AAA

Public Comment No. 185-NFPA 855-2024 [Section No. 16.1]

16.1 General.

Flow battery installations shall comply with the requirements of this chapter and Chapters 4 through 9 as specified in Table 16.1.

Table 16.1 Flow Battery Installations

Compliance Required	Applies	Reference
Construction documents	Yes	Section 4.2
Emergency planning and training	Yes	Section 4.3
HMA	Yes	Section 4.4
Combustible storage	Yes	Section 4.5
Equipment	Yes	Section 4.6
Installation	Yes	Section 4.7
Smoke and fire detection	Yes	Section 4.8
Fire control and suppression	Yes	Section ~~4~~ 16 .~~9~~ 5
Mobile ESS equipment and operations	Yes	Section 4.10
System interconnections	Yes	Chapter 5
Commissioning	Yes	Chapter 6
Operation and maintenance	Yes	Chapter 7
Decommissioning	Yes	Chapter 8
General	Yes	Section 9.1
Equipment	Yes	Section 9.2
Location classification	Yes	Section 9.3
Maximum stored energy	Yes	9.4.1
Size and separation	No	9.4.2
Location and applications	Yes	Section 9.5
Smoke and fire detection	Yes	9.6.1
Fire control and suppression	Yes	9.6.2
Water supply	No	9.6.3
Fire barriers	Yes	9.6.4
Exhaust ventilation	Yes	9.6.5.1
Spill control	Yes	9.6.5.2
Neutralization	Yes	9.6.5.3
Safety caps	No	9.6.5.4
Thermal runaway	No	9.6.5.5
Explosion control	No	9.6.5.6
Remediation measures	No	9.6.6

Statement of Problem and Substantiation for Public Comment

As this chapter has its own section smoke control and suppression, it should just point to 16.5 and not 4.9.

Related Item

- FR 100

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Submittal Date: Mon May 27 11:42:11 EDT 2024
Committee: ESS-AAA

Public Comment No. 188-NFPA 855-2024 [Section No. 16.1]

16.1 General.

Flow battery installations shall comply with the requirements of this chapter and Chapters 4 through 9 as specified in Table 16.1.

Table 16.1 Flow Battery Installations

Compliance Required	Applies	Reference
Construction documents	Yes	Section 4.2
Emergency planning and training	Yes	Section 4.3
HMA	Yes	Section 4.4
Combustible storage	Yes	Section 4.5
Equipment	Yes	Section 4.6
Installation	Yes	Section 4.7
Smoke and fire detection	Yes	Section 4.8, 9.6.1
Fire control and suppression	Yes	Section 4.9, 9.6.2
Mobile ESS equipment and operations	Yes	Section 4.10
System interconnections	Yes	Chapter 5
Commissioning	Yes	Chapter 6
Operation and maintenance	Yes	Chapter 7
Decommissioning	Yes	Chapter 8
General	Yes	Section 9.1
Equipment	Yes	Section 9.2
Location classification	Yes	Section 9.3
Maximum stored energy	Yes	9.4.1
Size and separation	No	9.4.2
Location and applications	Yes	Section 9.5
~~Smoke and fire detection~~	~~Yes~~	~~9.6.1~~
~~Fire control and suppression~~	~~Yes~~	~~9.6.2~~
Water supply	No	9.6.3
Fire barriers	Yes	9.6.4
Exhaust ventilation	Yes	9.6.5.1
Spill control	Yes	9.6.5.2
Neutralization	Yes	9.6.5.3
Safety caps	No	9.6.5.4
Thermal runaway	No	9.6.5.5
Explosion control	No	9.6.5.6
Remediation measures	No	9.6.6

Statement of Problem and Substantiation for Public Comment

Seems confusing that we have two lines with the same title pointing in two different chapters. Combine.

Related Item

- FR 100

Submitter Information Verification

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Submittal Date:	Mon May 27 11:59:06 EDT 2024
Committee:	ESS-AAA

Public Comment No. 186-NFPA 855-2024 [Section No. 17.1.2]

17.1.2

Unless modified by this chapter, the requirements of Chapters 1 through 14 shall apply *(see Table 17.1.2)*.

Table 17.1.2 Barge ESS Installations

Compliance Required	Barge	Reference
Administrative	Yes	Chapters 1, 2, and 3
General	Yes	Sections 4.1 through 4.7
Maximum size	Yes	9.5.2.4
Means of egress separation	Yes	9.5.2.6.1.7
Dedicated-use buildings	Yes	9.5.1.1
Enclosures	Yes	4.6.12
Clearance to exposures	Yes	9.5.3.1.3
Fire suppression and control	Yes	~~9.5.3.1.4~~ 17.9
Size and separation	Yes	9.4.2
Maximum stored energy	Yes	9.4.1
Elevation	Yes	4.7.7
Smoke and fire detection	Yes	~~9~~ 17 .~~6.1~~ 8
Signage	Yes	4.7.4
Occupied work centers	Yes*	9.5.1.2.1
Open rack installations	Yes	4.7.9
Technology-specific protection	Yes	9.6.5
Other technology	Yes	Chapters 10 through 13
Storage (off-spec)	Yes	Chapter 14
Stacking	Yes	Chapter 16
Commissioning	Yes	Chapter 6
Decommissioning	Yes	Chapter 8
Maintenance and operation	Yes	Chapter 7

Statement of Problem and Substantiation for Public Comment

Chapter 17 has its own references to Detection and Suppression. They should be the first point back. Additional the references to chapter 9 would indicated a bias to LIB. This chapter should be generic to technology, but if LIB is used should point out specific requirements.

Related Item

- FR 108

Submitter Information Verification

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Submittal Date: Mon May 27 11:49:40 EDT 2024
Committee: ESS-AAA

Public Comment No. 302-NFPA 855-2024 [Section No. 17.1.2]

17.1.2

Unless modified by this chapter, the requirements of Chapters 1 through 14 shall apply *(see Table 17.1.2)*.

Table 17.1.2 Barge ESS Installations

Compliance Required	Barge	Reference
Administrative	Yes	Chapters 1, 2, and 3
General	Yes	Sections 4.1 through 4.7
Maximum size	Yes	9.5.2.4
Means of egress separation	Yes	9.5.2.6.1.7
Dedicated-use buildings	Yes	9.5.1.1
Enclosures	Yes	4.6.12
Clearance to exposures	Yes	9.5.3.1.3
Fire suppression and control	Yes	9.5.3.1.4
Size and separation	Yes	9.4.2
~~Maximum stored energy~~	~~Yes~~	~~9.4.1~~
Elevation	Yes	4.7.7
Smoke and fire detection	Yes	9.6.1
Signage	Yes	4.7.4
Occupied work centers	Yes*	9.5.1.2.1
Open rack installations	Yes	4.7.9
Technology-specific protection	Yes	9.6.5
Other technology	Yes	Chapters 10 through 13
Storage (off-spec)	Yes	Chapter 14
Stacking	Yes	Chapter 16
Commissioning	Yes	Chapter 6
Decommissioning	Yes	Chapter 8
Maintenance and operation	Yes	Chapter 7

Statement of Problem and Substantiation for Public Comment

This series of proposals are from TG 29 Maximum Energy and as a result of discussions during the 1st Revision process. There is much value in the MAQ requirement which was simply added as a trigger for large-scale fire testing, it is an arbitrary number, and it adds confusion and just another layer of complexity in applying the code. Since you can exceed MAQ with just HMA, large-scale fire and explosion testing and AHJ approval, and this is done routinely, it really does not serve much purpose. A side effect is local jurisdictions misinterpreting the concept behind the MAQ and utilizing it to apply high hazard use designations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]	

Public Comment No. 295-NFPA 855-2024 [Section No. 9.5.1 [Excluding any Sub-Sections]]

Public Comment No. 297-NFPA 855-2024 [Section No. 9.5.2 [Excluding any Sub-Sections]]

Public Comment No. 298-NFPA 855-2024 [Section No. 9.5.2.1]

Public Comment No. 299-NFPA 855-2024 [Section No. 9.5.3.1 [Excluding any Sub-Sections]]

Public Comment No. 300-NFPA 855-2024 [Section No. 9.5.3.2.7 [Excluding any Sub-Sections]]

Public Comment No. 301-NFPA 855-2024 [Section No. 13.2 [Excluding any Sub-Sections]]

Public Comment No. 291-NFPA 855-2024 [Sections 9.4.1, 9.4.2]

Public Comment No. 304-NFPA 855-2024 [Section No. 4.4.1]

Related Item

- FR-4

Submitter Information Verification

Submitter Full Name: Robert Davidson
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Submittal Date: Thu May 30 13:28:46 EDT 2024
Committee: ESS-AAA

Public Comment No. 326-NFPA 855-2024 [Section No. 17.5.3]

17.5.3

When vessels or barges are transported and maintained at a dry-dock facility for maintenance and inspection, the state of charge shall be reduced and maintained to a state of charge of ~~30~~ 50 percent or lower as per manufacturer’s specifications and recommendations.

Statement of Problem and Substantiation for Public Comment

30% SOC is a requirement for air freight UN 38.3. Wartsila has performed SOC testing showing cells at 60% SOC did not go into thermal runaway but appeared to vent twice. Modules typically ship from manufacturers in the 35-40% SOC range. Recommend to increase to 50% and this can be decreased by manufacturer's recommendation.

Related Item

- First Revision No. 108-NFPA 855-2023 [Global Input]

Submitter Information Verification

Submitter Full Name: Chris Groves
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Submittal Date: Thu May 30 15:34:04 EDT 2024
Committee: ESS-AAA

Public Comment No. 328-NFPA 855-2024 [Section No. 17.8.1]

17.8.1

Systems used in required smoke and fire detection applications shall be suitable for use in the marine environment in which the vessel is deployed unless detectors and system are provided and entirely enclosed within listed ~~NEMA enclosures~~ boxes, enclosures, or utilization equipment .

Statement of Problem and Substantiation for Public Comment

It is not appropriate to reference NEMA listing as the listing could be UL or other. Changed to verbiage utilized in NFPA70 - ARTICLE 760 Fire Alarm Systems

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 330-NFPA 855-2024 [Section No. 17.9.1]	

Related Item

- First Revision No. 108-NFPA 855-2023 [Global Input]

Submitter Information Verification

Submitter Full Name:	Chris Groves
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Committee:	ESS-AAA

Public Comment No. 330-NFPA 855-2024 [Section No. 17.9.1]

17.9.1

Systems used in required fire control and suppression applications shall comply with either of the following:

(1) Be suitable for use in the marine environment in which the vessel is deployed

(2) Be provided and entirely enclosed within listed ~~NEMA enclosures~~ boxes, enclosures, or utilization equipment.

Statement of Problem and Substantiation for Public Comment

It is not appropriate to call out NEMA listing when boxes or enclosures can have UL or other listing. Text changed to reference in NFPA70 - ARTICLE 760 Fire Alarm Systems

Related Public Comments for This Document

Related Comment	**Relationship**
Public Comment No. 328-NFPA 855-2024 [Section No. 17.8.1]	same comment

Related Item

- Global FR-108

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 187-NFPA 855-2024 [Section No. 17.9.2]

17.9.2

Where approved, fire control and suppression systems that comply with maritime regulations shall be considered equivalent to the protection required by Section 4.~~8 .~~ 9

Statement of Problem and Substantiation for Public Comment

Editorial Suppression under Chapter 4 is section 4.9
Note do we need to point back to Chapter 9 specifically if LIB are used?

Related Item

- FR 108

Submitter Information Verification

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Submittal Date: Mon May 27 11:56:11 EDT 2024
Committee: ESS-AAA

Public Comment No. 243-NFPA 855-2024 [Section No. A.3.3.14]

A.3.3.14 Field Evaluation.

The ESS field evaluation is the process used to determine conformance with requirements for one-of-a-kind, used, or modified products that are not listed or labeled under a certification program. It is not meant nor can it replace UL 9540 listing. The International Accreditation Service® (IAS) verifies the competency of independent, third-party accreditation of field evaluation bodies (FEBs) using AC354, *Accreditation Criteria for Field Evaluation of Unlisted Electrical Equipment*. The AC354 accreditation process requires each FEB to demonstrate compliance with both NFPA 790 and NFPA 791. Field evaluations do not verify compliance to the appropriate test standard. Field evaluations do not verify compliance to the appropriate test standard such as 9540. It may be used as a component to achieve 9540.

Statement of Problem and Substantiation for Public Comment

Due to fabrications, one off, or supply chains, final integration may be at site. the Field evaluation may be a component of 9540 listing but doesn't replace 9540 even for certification.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 242-NFPA 855-2024 [Section No. 3.3.14]	

Related Item

- FR 52

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Wed May 29 10:50:22 EDT 2024
Committee: ESS-AAA

Public Comment No. 257-NFPA 855-2024 [Section No. A.3.3.37]

~~**A.3.3.37** – Thermal Walkaway.~~ –

~~Thermal walkway can occur in a lead-acid, nickel-cadmium, or other aqueous chemistry battery and can be controlled by removal of the charging source or reduction of the charging current.~~

Statement of Problem and Substantiation for Public Comment

Form Energy does not support the creation of the term “thermal walkaway”. As the condition is described in the proposed text of A.3.3.37, this is an overcharge failure and as such, is an entirely separate failure mode from thermal runaway. The term thermal walkway is misleading and may result in more confusion.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 256-NFPA 855-2024 [Section No. 3.3.37]	

Related Item

- FR-42

Submitter Information Verification

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Submittal Date: Wed May 29 14:17:40 EDT 2024
Committee: ESS-AAA

Public Comment No. 4-NFPA 855-2024 [Section No. A.3.3.37]

A.3.3.37 Thermal Walkaway.

Thermal walkway ~~can~~ is a form of destructive self-heating that can occur in a lead-acid, nickel-cadmium, or other aqueous chemistry ~~battery and~~ battery but can be controlled by removal of the charging source or reduction of the charging current. In contrast, thermal runaway in lithium-ion batteries is usually a very fast occurring process with limited that is more difficult to prevent and can occur without an external current source. The rates of heat and combustible gas production by an aqueous battery experiencing thermal walkaway are much less than those produced by a thermal runaway event. Given that aqueous batteries use a non-flammable electrolyte, the hazards associated with thermal walkaway are lower than thermal runaway. Among the aqueous batteries, Valve regulated batteries have a higher susceptibility to thermal walkaway due to their reduced electrolyte content.

Statement of Problem and Substantiation for Public Comment

As this is a new definition and associated annex, more information is added to help the readers more fully grasp the differences between the common failure modes of popular chemistries. Grasping these differences will allow for better comprehension of subsequent differentiation within the requirements of the standard.

Related Item

- PI-176

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 218-NFPA 855-2024 [Section No. A.4.4.1]

A.4.4.1

One form of hazard mitigation analysis (HMA) is a failure mode and effects analysis (FMEA), which is a systematic technique for failure analysis. An FMEA is often the first step of a system reliability study and involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded. Other formal methodologies for conducting the analysis can also be used depending on the complexity and type of the system being assessed. Guidance for analysis can be found in the following standards:

(1) IEC 60812

(2) IEC 61025

(3) MIL-STD-1629A

The mixing of lead-acid batteries with nickel-cadmium batteries will not present a risk of adverse interaction. An HMA is not necessary for these installations.

Many ESSs will be provided with safety equipment to meet the requirements of UL 9540, but in some circumstances additional safety equipment might need to be provided over and above what is included with the ESS. For example, an ESS installed indoors might depend upon exhaust ventilation provided with the installation in accordance with 9.6.6.1 to remove gases from the building. In this case, the HMA would need to address possible failures of such a system. It is not the intent of the HMA to evaluate the safety equipment provided as part of a listed ESS unless that equipment is installation dependent as determined by the testing to UL 9540 and UL 9540A.

Examples of potential adverse interactions between technologies that could increase safety risks, and thus merit the need for an HMA, include adverse interactions from the leaking of flow battery anolytes or catholytes, chemical reactions that could occur from different off-gassing products from two different battery types, and so forth.

The HMA should also consider the safety impact of toxic and highly toxic gases that may be emitted during abnormal conditions, such as thermal runaway. During failure conditions such as thermal runaway, fire, and abnormal faults, some ESS may emit toxic and highly toxic gases, such as CO, HF, HCl, H_2S, and HCN, amongst others. These emissions may present a health hazard to building occupants (indoor installations), surrounding communities (outdoor installations), and emergency personnel.

Statement of Problem and Substantiation for Public Comment

As Toxics are a concern to the public, adding annex clarification on possible evaluation and guidance under the HMA TG 6

Related Item

- CI 106

Submitter Information Verification

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Submittal Date: Tue May 28 10:08:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 255-NFPA 855-2024 [Section No. A.4.4.2.3]

A.4.4.2.3

Failure of a single critical safety component or system ~~such as the~~ (ex. fire alarm ~~or~~ , explosion control system ~~are not~~) **during a failure event such as thermal runaway is** not considered a dual fault condition. An example might be the loss of primary power ~~or secondary power. This~~ **to the explosion control system during a thermal runaway event.** This would be considered above and beyond the normal safety listing and evaluation. The protection features are required because the standard assumes an uncontrolled event occurred.

Statement of Problem and Substantiation for Public Comment

Form Energy agrees with the intent of this addition, but recommends updating the annex material for clarity.

Related Item

- FR-137 & FR-138

Submitter Information Verification

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Submittal Date:	Wed May 29 14:12:33 EDT 2024
Committee:	ESS-AAA

Public Comment No. 221-NFPA 855-2024 [Section No. A.4.6.11]

A.4.6.11

~~It is not the intent of~~
Section 4.6.11

~~to~~
does not address the

~~presence~~
production of toxic and highly toxic gases that

~~are~~
may be produced during abnormal conditions, such as thermal runaway or a fire

~~in the building.~~
(see Annex B4.5).

Statement of Problem and Substantiation for Public Comment

Editorial for clarification and wording.

Related Item

- CI 106

Submitter Information Verification

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Submittal Date: Tue May 28 10:12:45 EDT 2024
Committee: ESS-AAA

Public Comment No. 181-NFPA 855-2024 [Section No. A.4.9.3.1]

A.4.9.~~3~~ 2 .1

UL 9540A Installation Level Test, Method 2, ~~provides the data~~ can provide data needed to determine if other fixed fire control and suppression systems are suitable for the application. Additionally large scale fire testing or Equivalent test standards, as permitted in 9.1.5, can provide comparable data.

Statement of Problem and Substantiation for Public Comment

This annex doesn't point to Large Scale fire testing as an option for evaluating alternate methods. Added for clarification.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 180-NFPA 855-2024 [Section No. 4.9.3.1]	

Related Item

- FR 45

Submitter Information Verification

Submitter Full Name: Paul Hayes
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Submittal Date: Mon May 27 11:17:14 EDT 2024
Committee: ESS-AAA

Public Comment No. 207-NFPA 855-2024 [New Section after A.4.9.3.2]

A.4.9.3.3

Condensed Aerosol systems may be used in a total flooding design configuration, in accordance with the specific ESS installation or enclosure being protected, and in accordance with the manufacturer's design instructions. When using a condensed aerosol system, the ESS enclosure should be built in a permanent fashion and such that it is adequate to contain and maintain an appropriate design density of aerosol in the protected space. System features such as generator placement and mounting, clearance zones, actuation method, and other characteristics need to be determined for each manufacturer's system through appropriate listings / approvals or fire testing in accordance with 9.1.5 and must be designed, installed, and tested in accordance with NFPA 2010.

A venting system should be designed to allow for venting of potentially explosive gases generated through the thermal runaway process, while retaining an adequate level of aerosol to achieve and maintain appropriate design density per the manufacturer's design instructions. Accommodation for excessive leakage (due to venting) and/or multiple aerosol unit discharge stages may be necessary to achieve the design objectives. See section G.6.1.6 for additional information.

Statement of Problem and Substantiation for Public Comment

The First Revision No. 45-NFPA 855-2023 decision stated that "Other fire control and suppression have not been shown to effectively control lithium battery fires except NFPA 15 and NFPA 750 systems" and therefore they were removed from the code.

FirePro Systems Limited, manufacturer and supplier of the FirePro Condensed Aerosol Fire Suppression Systems has conducted extensive testing on Lithium-Ion batteries in several countries, such as the Netherlands, Italy, and South Korea.

Our Research and Development program on Lithium-ion batteries began in 2016. FirePro technology has been tested in various Lithium-Ion battery fire scenarios by accredited laboratories, certification bodies, and Lithium-Ion battery manufacturers, demonstrating its effectiveness in controlling thermal runaway and suppressing Lithium-Ion battery fires.

Detailed below are the various tests undertaken, the results and conclusions, which we believe provides sufficient evidence of the positive effect of installing condensed aerosol suppression in Stationary Energy Storage Systems covered under NFPA 855.

Test 1: Li-Ion Battery Fire Test– Safety for storage and transport of Lithium Batteries (Netherlands 2016)

- Battery manufacturer Cleantron, capacity: 1.9 kWh fully charged
- Test enclosure: 40ft container
- Thermal reaction was started with a glow plug
- Lithium battery inside a synthetic barrel
- Several cradles, squire and round containers/bins/other objects were placed in order to create a realistic test and to be able to determine any adverse effect on surrounding materials.
- Witnessed by KIWA Netherland BV
- Tests performed at Twente Safety Campus, Oude Vliegveldweg, Deurmingen, Netherlands
- Conclusion - "A FirePro® condensed aerosol system is able to achieve suppression and control mode over a period of at least 30 minutes, after ignition of a single 1,9 kWh Cleantron battery, with an actual aerosol density of 61 grams per cubic meter"

- KIWA Report – Report of fire tests on Li-ion batteries based on condensed aerosol (2016)

Test 2: Li-Ion Battery Fire Test (Netherlands, 2019) – “Testing a Suppression System for packaged batteries for E-bikes”
- Lithium-Ion batteries on pallets: 144 x (36V/14.5Ah) – 2088 Ah
- Test enclosure: 40 ft metal container
- Start battery burning process with heating plug
- Tests performed at RelyOn Nutec Fire Academy test site
- Conclusion – “…The container reaches its homogeny density after 60 seconds after activation. The temperature drops to 86 °C around the activated batteries. The first temperature knocked down by the fire protection system when its reached its soaking steady state is 799°C. 4 minutes later drops the temperature below 30°C and stays there. This demonstrates the performance of the fire protection system to suppress and control this type of fire scenarios if the density of the medium is (kept) sufficient…”
- KIWA Report – Testing a Suppression System for packaged batteries for E-bikes (2019)

Test 3: Lithium-Ion Battery Fire Tests (Italy, 2019)
- Battery type: Lithium Iron Phosphate battery LiFePO4 26650 – 3.2V 3.3Ah
- Test enclosure: 7.55 m3
- Thermal runaway induced by overcharging, forced discharge, heating devices (glow plugs, electric coils), short circuit
- Tests performed at TCS Fire Test Facilities
- Conclusion – “In all the extinguishing tests the FirePro Condensed Aerosol Technology demonstrated the capability to extinguish the fire and control/suppress the battery runaway utilizing an Aerosol Density of 200 g/ m3 of Solid Compound corresponding to a net Condensed Aerosol 130g/ m3.”
- White Paper – Lithium-ion and Lithium-Polymers Batteries Fire Protection Innovative Engineering Solutions (2019)

Test 4: Fire Suppression System Test on LG Lithium-Ion Battery Fires a Consequence of Thermal Runaway (Korea, 2019)
- LG-Chem Lithium-Ion battery cells (3 tightly packed cells)
- Cell type: pouch (310mm x 95mm x 15mm)
- Cell capacity 54Ah (normal) – for this test samples 64Ah
- Cell energy: 0.2214 kWh
- Cell nominal voltage: 4.1 V
- Test enclosure: 2.84m x 2.23m x 2.34m = 14.82 m3
- A heating pad was used with the bottom battery cell so as to gradually increase the temperature until the thermal runaway started
- Tests conducted by KFI
- Conclusion – “Li-ion battery fires are challenging and difficult to be controlled. Based on the results, the fire was successfully suppressed, and no re-ignition occurred for the remaining 50min of the test. FirePro condensed aerosol technology managed to suppress and control the li-ion battery fire successfully, with a gross extinguishing density of 200g/m3.”
- Test Report – Fire Suppression System Test on LG Lithium-ion Batteries Fires as Consequence of Thermal Runaway (2019)

Test 5: Lithium-ion / Li-Polymer Thermal Runaway tests (Italy, 2020)
- Battery types: Lithium-Ion and Lithium-Polymer Cells
- Cell types: pouch, metallic box type, cylindrical
- Test enclosures: steel reinforced concrete construction, high pressure safety test vessel, vertical steel mesh vessel cylindrical shape
- Thermal runaway induced by overcharging the cell
- Tests performed at AlbaRubens srl Test Facilities
- Conclusion – “FirePro Condensed Aerosol demonstrated the ability to control and to further interrupt the thermal runaway, confirming the evidence arose from the research tests performed at the TCS Test Facilities, see “Lithium Polymers Batteries Innovative Engineering Solutions” by Luciano Borghetti.” – refer to “Test 3: Lithium-Ion Battery Fire Tests (Italy, 2019)” above.
- White Paper – Lithium-Ion and Lithium-Polymers Batteries Runaway Investigation (2020)

Test 6: Investigation of the Effectiveness of FirePro Aerosol Extinguishing System in Controlling Lithium-Ion Battery Thermal Runaway - Liion Tablets (Italy, 2022)
- Pouch type Lithium-Ion batteries, Cathode: (622: 60% Nickel, 20% Manganese, 20% Cobalt),

Anode: Graphite

- 2 LG Chem 12-cell pouch modules (each cell of 3.7V, 33Ah, energy 122.1Wh), Module size: 240 x 180 x 130 (h) mm (5.62dm3)
- Experimental box (329 x 720 x 250 mm)
- Thermal runaway triggered by overloading of a single cell
- Tests performed at AlbaRubens srl Test Facilities
- Conclusion – “The FirePro FPC Liion Tablet, generating Condensed Aerosol, demonstrated the ability to control/suppress and interrupt the battery thermal runaway, confirming the results of the previous tests ran at TCS Test Facilities and AlbaRubens Test Facilities.” – refer to “Test 3: Lithium-Ion Battery Fire Tests (Italy, 2019)” above.
- Test Report – Investigation of the Effectiveness of FirePro Aerosol Extinguishing System in Controlling Lithium-Ion Battery Thermal Runaway (2022)

Test 7: FirePro Condensed Aerosol Systems to control and interrupt the lithium-polymer batteries thermal runaway inside a confined space (Italy, 2023)

- 3 NMC Pouch Type modules, cells aggregate (each module of 48V, 1.4kWh), Module size: 240x160x110h mm
- 3 NCA Cylindrical Metallic Body modules, cells aggregate (each module of 52V, 2.5kWh), Module size 520x260x75h mm
- Experimental box (100 x 100 x 100 cm)
- The thermal runaway phenomenon was induced by overheating a single cell of the module, utilizing an electric coil.
- Tests performed at RT CERT s.r.l. Test Facilities
- Conclusion – “All the four tests were passed successfully, according to acceptance criteria expressed in §4, utilizing an aerosol factor of 201,0 grams per cubic meter of FPC Solid Compound (no intervention of the backup FP500S FirePro Aerosol Generator with BTA was observed)”
- Test Report – “FirePro Condensed Aerosol Systems to control and interrupt the lithium-polymer batteries thermal runaway inside a confined space.”

Full reports are also available.

Related Item

- FR-45-NFPA 855-2023

Submitter Information Verification

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Submittal Date:	Tue May 28 08:40:27 EDT 2024
Committee:	ESS-AAA

Public Comment No. 102-NFPA 855-2024 [Section No. A.4.9.3.2]

A.4.9.3.2

Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific ESS installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer's system through fire and explosion testing in accordance with 9.1.5 to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750. See G.6.1.3 for more information on the use of water mist systems with LIB-based ESSs.

Condensed Aerosol . Condensed Aerosol systems may be used in a total flooding design configuration, in accordance with the specific ESS installation or enclosure being protected, and in accordance with the manufacturer's design instructions. When using a condensed aerosol system, the ESS enclosure should be built in a permanent fashion and such that it is adequate to contain and maintain an appropriate design density of aerosol in the protected space. System features such as generator placement, clearance zones, actuation method, and other characteristics need to be determined for each manufacturer's system through fire testing in accordance with 9.1.5 and must be designed, installed, and tested in accordance with NFPA 2010.

A design balance must be achieved between venting of the ESS enclosure for potentially explosive gases per *NFPA 68* *Explosion Protection by Deflagration Venting* and retention of the aerosol to achieve and maintain appropriate aerosol design density per the manufacturer's design instructions. Accommodation for excessive leakage (due to venting) and/or multiple aerosol unit discharge stages may be necessary to achieve the design objectives. See section G.6.1.6 for additional information.

Statement of Problem and Substantiation for Public Comment

Submitter has also proposed re-entry of reference to several NFPA standards in section 4.9.3.2. As such, additional explanatory material is appropriate in section A.4.9.3.2 to provide further guidance to the reader on use of aerosol systems for ESS applications.

Related Item

- further explanation of aerosol systems referencing 4.9.3.2. and reference to NFPA 2010

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Submittal Date: Mon May 13 15:15:49 EDT 2024
Committee: ESS-AAA

Public Comment No. 183-NFPA 855-2024 [Section No. A.4.9.3.2]

A.4.9.3.~~2~~ — 1 _

Gaseous Agents. Gaseous agent fire suppression systems can be used to protect Non-LIB ESS fires based on large scale testing.

For LIB based ESSs See Chapter 9 or G.6.1.4 for more information on the use of gaseous/clean agent fire suppression.

Gaseous agents can be used in either of the following two ways:

(1) Total flooding systems are used where there is a permanent enclosure around the fire hazard that is adequate to enable the design concentration to be built up and maintained for the time required to ensure the complete and permanent extinguishment of a fire for the specific combustible materials involved. For total flooding systems, potential leakage sources should be included in the gaseous agent design quantities, which should include leakage through ventilation dampers. Usually, ventilation dampers are either gravity actuated (i.e., close when the ventilation fans automatically shut down upon gaseous agent discharge) or pressure actuated (i.e., close by means of counterweight and a pressure-operated latch that is activated by the gaseous agent). Leakage from the interface between the enclosure walls and the foundation should also be taken into consideration. For ESS enclosures where the normal temperature of the enclosure exceeds 200°F (93°C) or is below 0°F (−18°C), gaseous agent levels should be adjusted as required by the appropriate NFPA standard or the manufacturer's instruction manual.

(2) Local application systems are used for the extinguishment of surface fires of combustible gases, liquids, or solids where the fire hazard is not enclosed or where the enclosure does not conform to the requirements for a total flooding system. For local application systems, it is imperative that the entire fire hazard be protected. The hazard area should include all areas that are subject to spillage, leakage, splashing, condensation, and so forth and are of combustible materials that might extend a fire outside the protected area or lead a fire into the protected area. This type of hazard could necessitate dikes, drains, or trenches to contain any combustible material leakage. When multiple ESS equipment fire hazards are in an area such that they are interposing, provisions should be made to ensure that the hazards can be protected simultaneously, which could involve subdividing the hazards into sections and providing independent protection to each section.

Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific ESS installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer's system through fire and explosion testing in accordance with 9.1.5 to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750. See G.6.1.3 for more information on the use of water mist systems with LIB-based ESSs.

Statement of Problem and Substantiation for Public Comment

With the addition of other NFPA standards back in to Chapter 4.9.3. this information is appropriate for other technologies beyond LIB.

Related Item

- FR 45

Submitter Information Verification

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Submittal Date: Mon May 27 11:32:31 EDT 2024
Committee: ESS-AAA

Public Comment No. 250-NFPA 855-2024 [Section No. A.4.9.3.2]

A.4.9.3.2

Water mist fire suppression systems need to be designed specifically for use with the size and configuration of the specific ESS installation or enclosure being protected. Currently there is no generic design method recognized for water mist systems. System features such as nozzle spacing, flow rate, drop size distribution, cone angle, and other characteristics need to be determined for each manufacturer's system through fire and explosion testing in accordance with 9.1.5 to obtain a listing for each specific application and must be designed, installed, and tested in accordance with NFPA 750. See G.6.1.3 for more information on the use of water mist systems with LIB-based ESSs

Inerting suppression systems can extinguish battery fire and prevent propogation of thermal runaway when used in accordance with engineered design concentrations . Gas concentration shall be maintained for a period sufficientenough to prevent reignition before the space is accessed. The hazard event gas levels and temperatures inside the ESS should be monitored to provide information regarding the ambient conditions inside the ESS. Pressure relief venting shall be installed where appropriate for the protected ESS. Purging of the protected space shall be done with a regular venting system, HVAC system or manual discharge of a secondary inerting system before the ESS is accessed by personnel. See G.6.1.5 for more information on the use of inerting systems.

Statement of Problem and Substantiation for Public Comment

In the right scenario, inerting suppression systems can extinguish a battery fire when deployed in a high enough volume and can prevent propagation of thermal runaway from damaged cell/module to nearby cell/modules. Oxygen produced by an off-gassing cell does not produce sufficient oxygen to sustain fire on its own and would require supplemental oxygen from the environment. Once the oxygen in the ESS is depleted or reduced to level low enough through inerting, even oxygen produced by a cell in thermal runaway will not provide enough oxygen ignite the flame.

(Ofodike Ezekoye PhD,PE 's University of Teas at Austin November 20, 2023 presentation:

https://players.brightcove.net/1640544031001/default_default/index.html?videoId=6341563316112)

(KIT Report:

https://www.ffb.kit.edu/download/IMK%20Ber.%20Nr.%20192%20Kunkelmann%20Lithium-Ionen-%20und%20Lithium-Metall-Batterien%20Brandbekaempfung.pdf)

With this information it also makes sense to add it to Annex G at this time for consistency.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 227-NFPA 855-2024 [Section No. G.6.1.5]	Submitter
Public Comment No. 277-NFPA 855-2024 [Section No. 4.9.3.2]	

Related Item

- FR 45 4.9.3.2

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Committee: ESS-AAA

Public Comment No. 135-NFPA 855-2024 [Section No. A.4.10.1]

A.4.10.1

The duration of the required EPSS of SEPSS as defined in Class X is time, in hours, as required by the application, code, or user. The HMA is used to determine a credible event and the expected duration of the event. ~~Typically,~~ The design of the EPSS system is used as part of the engineering analysis (along with, HMA, Fire Risk/Explosion Risk and electrical distribution system design) to show that the credible event and the duration of the event is supported by EPSS. T ypically, for systems operating in standby mode, the duration should be a minimum of 24 hours for LIB ~~BESSs~~ ESSs . Determining time requirements for an EPSS or SEPSS in alarm mode should be based on probable response times of the SME or first responders. This ensures that the critical safety systems are functional to provide appropriate information to the SME or the first responders. Other references and codes might include the terms *secondary power*, *standby power*, or *auxiliary power*. For safety reliability, they are assumed to have the same requirements as an EPSS or SEPSS.

Statement of Problem and Substantiation for Public Comment

The power back up requirements within NFPA 855 for critical safety system was consistently applied across multiple chapters. Additional definitions and a new Section 4.10 have been created to consolidate the power requirements and provide consistency. NFPA TG 27 has reviewed the PI 194 and provided additional clarification to requirements of NFPA 70, better definitions of response times, load requirements, engineering requirements and survivability input.

Related Item

- FR 194 • FR 190

Submitter Information Verification

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Submittal Date: Thu May 23 10:36:37 EDT 2024
Committee: ESS-AAA

Public Comment No. 204-NFPA 855-2024 [Section No. A.7.1.2(5)]

A.7.1.2(5)

Examples of engineering documentation include one-line diagrams, lock-out/tag-out procedures, and shock and arc flash labeling.

A.7.1.3.3

Each ESS that is over 20 kWh in capacity or 900 square feet of energy storage space in a room or area that is installed inside another facility should have a specific ESS placard placed at the building points of entry for first responders and on each entry door to the ESS room/area.

Figure A.7.1.3.3(a) Suggested NFPA 704 Site and Room Placarding for ESS Inside of a Building Where Not All Building Spaces Contain ESS.

For dedicated SESS facilities, each first responder point of entry should have an aggregate site capacity/size placard.

Each exterior or dedicated structure SESS that is over 600 kWh in capacity or 5,000 square feet in area should have placards on the structure so that all points of access to the structure can see the placard(s) on approach.

Exterior points of entry where placards should be installed include:

(1) The entrance at the legal address of record

(2) The secondary point of assigned emergency access (as applicable)

(3) Entrances where fire alarm or emergency system annunciators are located

(4) Other entrances identified in the HMA as being integral to emergency response operations

Figure A.7.1.3.3(b) Suggested NFPA 704 Site and Enclosure Placarding for Larger Outdoor Multiple Enclosure ESS Locations.

Additional Proposed Changes

File Name	Description	Approved
placard_inside_building.jpg	ESS site and indoor room NFPA 704 diamond placarding suggestions	
large_container_field_with_differing_hazards_placarding.jpg	suggestions for NFPA 704 hazard diamonds for larger outdoor ESS containerized sites	

Statement of Problem and Substantiation for Public Comment

NFPA 855 Task Group 28 was assigned to come up with improvements to NFPA 704 (13 PIs were submitted) as well as NFPA 704 diamond placard placement guidance to put in NFPA 855. While the best place to put this information in 855 is a new subsection to 4.7.5 and an associated Annex A comment for it, there was no PI to tie it to in that section, so we chose the 2nd best place in the document (the SDS section) to put it. This is the Annex material for the first PI that was submitted relevant to our task.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 203-NFPA 855-2024 [Section No. 7.1.3]	body text feeding this Annex material
Public Comment No. 203-NFPA 855-2024 [Section No. 7.1.3]	

Related Item

- PI-234

Submitter Information Verification

Submitter Full Name:	Curtis Ashton
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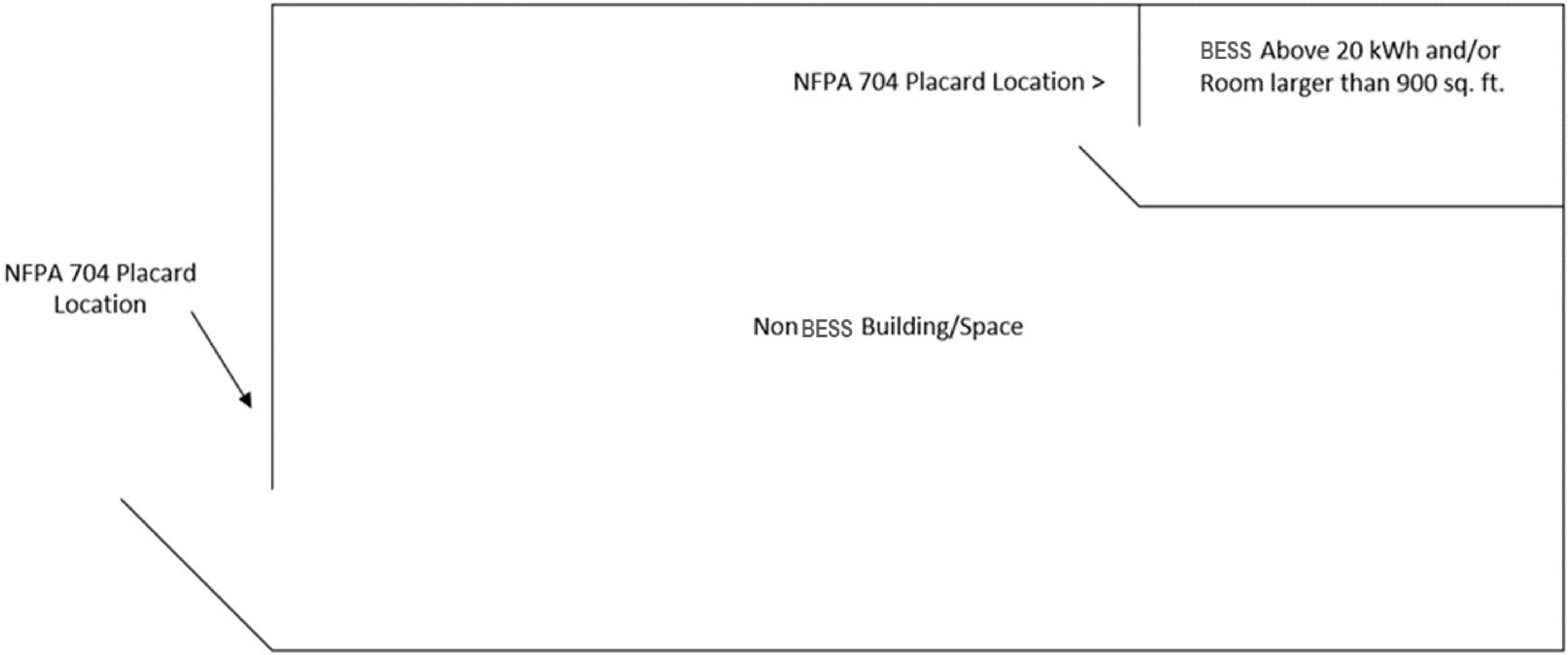
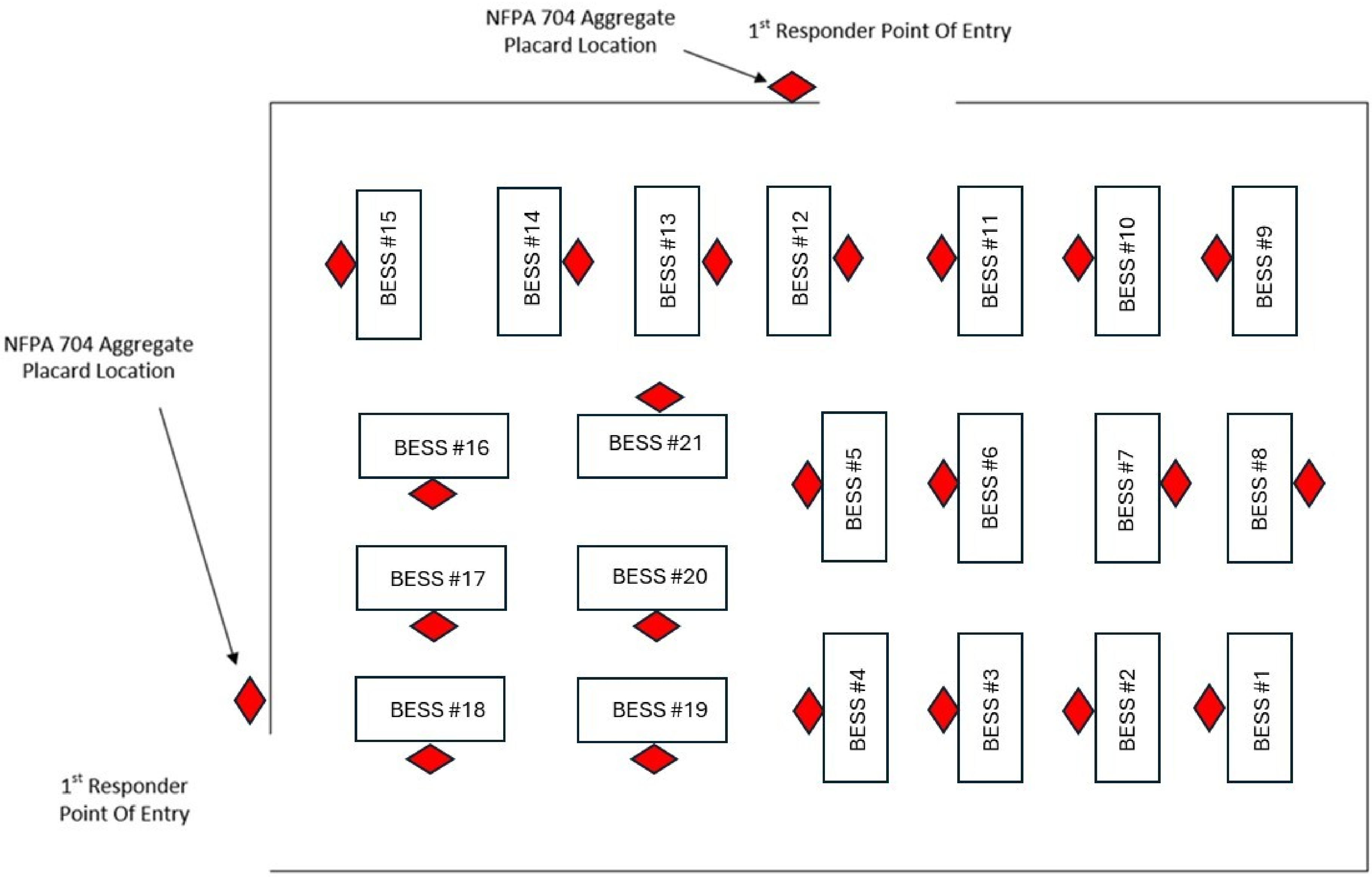
Submittal Date:	Mon May 27 22:30:20 EDT 2024
Committee:	ESS-AAA


NFPA 704 Placard Location >
BESS Above 20 kWh and/or Room larger than 900 sq. ft.
NFPA 704 Placard Location
Non BESS Building/Space


NFPA 704 Aggregate Placard Location
1st Responder Point Of Entry
BESS #15
BESS #14
BESS #13
BESS #12
BESS #11
BESS #10
BESS #9
NFPA 704 Aggregate Placard Location
BESS #16
BESS #21
BESS #5
BESS #6
BESS #7
BESS #8
BESS #17
BESS #20
BESS #18
BESS #19
BESS #4
BESS #3
BESS #2
BESS #1
1st Responder Point Of Entry

Public Comment No. 197-NFPA 855-2024 [Section No. A.9.1.5.1]

A.9.1.5.1

See Annex notes **A .9.1.5.1.2** for Test objectives of the large scale test.

9540A - A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of ~~both explosionproof gases generated and toxic and highly toxic emissions at~~ combustible gases generated at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the ~~fire event~~ thermal runaway propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.

The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.

The test sequence in UL 9540A includes, in order, cell-, module-, unit-, and installation-level tests. If the following individual test results are obtained, no further testing in the sequence is needed:

(1) *Cell-level test.* Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918.

(2) *Module-level test.* The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable.

(3) *Unit-level test.* All of the following results are obtained:

    (4) Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

    (5) Temperature increase of target walls less than 97°C (175°F).

    (6) No explosion hazards exhibited by the product.

    (7) No flaming beyond outer dimensions of

    ~~BESS~~

    (a) ESS unit (indoor, wall mount).

(8) *Installation-level test.* Acceptable performance includes all of the following:

    (9) Target

    ~~BESS~~

    (a) ESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

    (b) Temperature increase of target walls less than 97°C (175°F).

    (c) The flame indicator does not propagate flames beyond the width of the initiating

    ~~BESS~~

    (a) ESS .

    (b) No flaming outside the test room and meets the heat flux limits for the means of egress.

The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire ~~, explosion, and toxic and highly toxic emission protection~~ and explosion protection required for an ESS installation.

Statement of Problem and Substantiation for Public Comment

As TOxic gases are not part of 9540A, there being removed. Also making refrence to the largescale testing requirements and utilizing the term Thermal Runaway propogation.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 196-NFPA 855-2024 [Section No. A.9.1.5.1.2]	
Public Comment No. 194-NFPA 855-2024 [Section No. 9.1.5]	

Related Item

- FR 139

Submitter Information Verification

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Submittal Date:	Mon May 27 14:07:53 EDT 2024
Committee:	ESS-AAA

Public Comment No. 253-NFPA 855-2024 [Section No. A.9.1.5.1]

A.9.1.5.1

A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of both explosionproof gases generated and toxic and highly toxic emissions at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.

The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.

The test sequence in UL 9540A includes, in order, cell-, module-, unit-, and installation-level tests. If the following individual test results are obtained, no further testing in the sequence is needed:

(1) *Cell-level test.* Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918.

(2) *Module-level test.* The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable.

(3) *Unit-level test.* All of the following results are obtained:

  (4) Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

  (5) Temperature increase of target walls less than 97°C (175°F).

  (6) No explosion hazards exhibited by the product.

  (7) No flaming beyond outer dimensions of BESS unit (indoor, wall mount).

(8) *Installation-level test.* Acceptable performance includes all of the following:

  (9) Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

  (10) Temperature increase of target walls less than 97°C (175°F).

  (11) The flame indicator does not propagate flames beyond the width of the initiating BESS.

  (12) No flaming outside the test room and meets the heat flux limits for the means of egress.

The test sequence outlined may not represent requirements for non-lithium ion chemistries. See UL9540A for test sequence requirements for alternative chemistries.

The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire, explosion, and toxic and highly toxic emission protection required for an ESS installation.

Statement of Problem and Substantiation for Public Comment

UL 9540A procedures for alternative chemistries have different test criteria than the standard (lithium-ion focused) test procedure. Including test sequence requirements for certain chemistries and not acknowledging exceptions or procedural differences will lead to confusion amongst AHJs and risk inaccurate enforcement. If NFPA 855 reprints partial information from other standards, it also must be acknowledged that additional exemptions are not represented and may apply. As such, it is recommended that the standard specifically states different requirements may apply to alternative chemistries for clarity.

Related Item

- FR-139

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 284-NFPA 855-2024 [Section No. A.9.1.5.1]

A.9.1.5.1

A UL 9540A test ~~or equivalent test~~ should evaluate the fire characteristics of the composition of both ~~explosionproof~~ flammable gases generated and toxic and highly toxic emissions at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.

The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.

The test sequence in UL 9540A includes, in order, cell-, module-, unit-, and installation-level tests. If the following individual test results are obtained, no further testing in the sequence is needed:

(1) *Cell-level test.* Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918.

(2) *Module-level test.* The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable.

(3) *Unit-level test.* All of the following results are obtained:

    (4) Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

    (5) Temperature increase of target walls less than 97°C (175°F).

    (6) No explosion hazards exhibited by the product.

    (7) No flaming beyond outer dimensions of BESS unit (indoor, wall mount).

(8) *Installation-level test.* Acceptable performance includes all of the following:

    (9) Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.

    (10) Temperature increase of target walls less than 97°C (175°F).

    (11) The flame indicator does not propagate flames beyond the width of the initiating BESS.

    (12) No flaming outside the test room and meets the heat flux limits for the means of egress.

The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire, explosion, and toxic and highly toxic emission protection required for an ESS installation.

UL 9540B large scale fire propagation testing is intended to be used in addition to UL 9540A fire propagation testing to evaluate the fire propagation behavior of a residential BESS installation. In comparison to UL 9540A, the UL 9540B *Fire Propagation Test* requires a thermal runaway propagation event to be created within the BESS along with an internal fire condition created by spark ignitors or glow plugs. UL 9540B is currently only intended for evaluating residential ESS, but, where approved, its test methodology may form the basis for the “large-scale fire testing” anticipated in this section for nonresidential ESS.

Statement of Problem and Substantiation for Public Comment

This public comment accomplishes the following:
1. Removes reference to "or equivalent test standard" which was removed from the body of the code in the first draft.
2. Replaces explosionproof gas, an incorrect term, with flammable gas.
3. Introduces a reference to the UL 9540B fire propagation test, which while currently limited to fire propagation testing of residential ESS, but it's testing concepts may be expanded to form the basis for "large-scale testing", a rather subject term in the body of the standard.

Related Item

- Public Inputs No. 356, 37, FR-139

Submitter Information Verification

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Committee: ESS-AAA

Public Comment No. 339-NFPA 855-2024 [Section No. A.9.1.5.1]

A.9.1.5.1

A UL 9540A test or equivalent test should evaluate the fire characteristics of the composition of both explosionproof gases generated and toxic and highly toxic emissions at cell level, module level, and unit and installation levels for an indoor installation of an ESS that undergoes thermal runaway, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit level and indoor installation level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level.

The test methodology in UL 9540A determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.

The test sequence in UL 9540A includes, in order, cell-, module-, unit-, and installation-level tests. If the following individual test results are obtained, no further testing in the sequence is needed:

(1) *Cell-level test.* Thermal runaway cannot be induced in the cell and the cell vent gas is nonflammable in air in accordance with ASTM E918.

(2) *Module-level test.* The effects of thermal runaway are contained by the module design, and cell vent gas (based on the cell level test) is nonflammable.

(3) *Unit-level test.* All of the following results are obtained:

  (4) Target BESS

  ~~temperatures~~

  (a) module temperatures less than

  ~~cell surface~~

  (a) cell venting temperature

  ~~at gas venting~~

  (a) and meets the heat flux limits for means of egress (for BESS units intended for near exposures) .

  (b) Temperature increase of target walls

  ~~less than~~

  (a) do not exceed 97°C (175°F) above ambient .

  (b) No explosion hazards exhibited by the product.

  (c) No flaming beyond outer dimensions of BESS unit (indoor floor mount , indoor and outdoor wall mount).

(5) *Installation-level test.* Acceptable performance includes all of the following:

  (6) Target BESS temperatures less than

  ~~cell surface~~

  (a) cell venting temperature

  ~~at gas venting~~

  (a) and meets the heat flux limits for means of egress (for BESS units intended for near exposure) .

  (b) Temperature increase of target walls

  ~~less than~~

(a) do not exceed 97°C (175°F) above ambient .

(b) The flame indicator does not propagate flames beyond the

~~width~~

(a) enclosure dimensions of the initiating BESS.

(b) No flaming outside the test room and meets the heat flux limits for the means of egress.

(c) There is no observation of detonation or deflagration(unless mitigated by an engineered deflagration protection system).

(d) No re-ignition within the BESS after test and sprinkler usage discontinued.

The data generated by the fire and explosion testing is intended to be used by manufacturers, system designers, and AHJs to determine the need for fire, explosion, and toxic and highly toxic emission protection required for an ESS installation.

Statement of Problem and Substantiation for Public Comment

Corrected verbiage to be in line with UL 9540A third edition performance criteria

Related Item

- FR-139

Submitter Information Verification

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Submittal Date: Thu May 30 16:26:00 EDT 2024
Committee: ESS-AAA

Public Comment No. 196-NFPA 855-2024 [Section No. A.9.1.5.1.2]

A.9.1.5.1.2

Intentional ignition of the vent gases informs the degree of fire hazard presented by the released flammable gases and the development of a fire protection strategy. The ignition source should be of sufficient magnitude such as generated by a spark igniter, glow plug, or pilot flame located in close proximity to the origin of the vented gases, but outside of the module of origin, to cause prompt ignition of the flammable gases. External ignition in this manner is not intended to address deflagration mitigation as required in 9.1.5.1.4.

- TEST OBJECTIVE (Focus on Consequence): Evaluate the conditions resulting from a fire within a battery energy storage system (including non-battery components) to determine whether there is a propagation/ignition risk to adjacent units or exposures. The test setup should reflect the anticipated installed condition of the BESS and should be conducted without any active suppression, if provided, in the initiating unit to ensure a worst-case anticipated exposure. The test should generate quantitative data that can be used to assess the risk posed by the system to other equipment or personnel

Test Assumptions

(1) Applicable for Indoor and Outdoor system (not residential)

(2) Producing the largest fire exposure to adjacent or nearby units or exposures

(3) The requirements assume an abuse condition leading to a thermal runaway propagation event and ignition of flammable vent gases.,

(4) Consider: Start the evaluation AFTER other safety mitigations have operated (doors open, etc.) The test conditions will vary based on the specifics of the BESS design, however the test should setup should allow for a full involved BESS to serve as the initiator.

(5) Largest fire exposure assumes… The fire exposure should account for doors/panels being removed to simulate a post deflagration event in which sufficient oxygen is provided for combustion.

(6) Producing the largest fire exposure to adjacent or nearby units or exposures This will allow for maximum anticipated heat flux and temperature to be measured at the locations of adjacent and target units to quantify the risk.

(7) Flame Propagation Testing (FPT): Flaming Propagation Testing (FPT) is designed to evaluate the dynamics of and hazards presented by intraunit (module-to-module) and inter-unit (unit-to-unit) flaming propagation.

(8) The test design considers an incident where an ESS under the intended operating condition experiences a failure event that operates any explosion mitigation devices. The explosion mitigation devices must be separately evaluated to show proper performance." While the FPT is focused on flame propagation additional testing should be performed to determine that the method and mode of deflagration protection is sufficient for the BESS

(9) Performance criteria – If flames penetrate through interconnection paths, assume fire propagation into adjacent container. A screening test should be performed on a BESS enclosure, without batteries, to evaluate the interconnection details between units to ensure that propagation hazards between units via electrical or equipment chases, ductwork, or other connections is understood. The test involves a pre-mixed flame sand burner (Q* HRR TBD) that is placed in the BESS and is operated until propagation is observed or for the duration of resistance stated by the manufacturer.

(10) UNIT ENCLOSURE: Outside dimensions of finished product under evaluation. UNIT – A frame, rack or enclosure that consists of a functional BESS, which includes components and sub-assemblies such as cells, modules, BMS, ventilation devices, and other ancillary equipment.

Statement of Problem and Substantiation for Public Comment

With the additional of the large scale fire test, further clarification is required. Test objectives are added to the Annex.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 193-NFPA 855-2024 [Section No. 9.1.5.1 [Excluding any Sub-Sections]]	
Public Comment No. 195-NFPA 855-2024 [Section No. A.9.1.5.1.3]	
Public Comment No. 197-NFPA 855-2024 [Section No. A.9.1.5.1]	

Related Item

- FR 139

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Committee:	ESS-AAA

Public Comment No. 195-NFPA 855-2024 [Section No. A.9.1.5.1.3]

~~A.9.1.5.1.3~~ —

~~Changes in an installation configuration, including the internal architecture of modules and units, that don't match the parameters tested, such as size and separation, cell type, or energy density, should not be accepted unless it can be shown that the configuration provides equivalent results. For example, scaling such as height, depth, and spacing need to conform to the configuration of the test. Changes also might include multiple levels of units on top of each other, located on a mezzanine floor above, or back-to-back units. These configurations might not have been evaluated in the test.~~

Statement of Problem and Substantiation for Public Comment

Statement moved to new section for revision to requirements of large scale fire testing.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 194-NFPA 855-2024 [Section No. 9.1.5]	
Public Comment No. 196-NFPA 855-2024 [Section No. A.9.1.5.1.2]	

Related Item

- FR 139

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Committee: ESS-AAA

Public Comment No. 318-NFPA 855-2024 [Section No. A.9.2.1.2.1]

A.9.2.1.2.1

~~Lead-acid and nickel-cadmium~~ Valve regulated lead-acid batteries listed to UL 1973 are often assembled with listed chargers and other listed components for use in stationary standby applications. In these instances, ~~listing at the system level to UL 9540 might not be necessary for installations less than 600 V dc.~~ listing to UL 9540 is not required for installations less than1500 Vdc.

Vented lead-acid and nickel-cadmium batteries used in stationary standby applications installed in systems less than 1500Vdc do not require UL 1973 ir UL 9540 listing.

A vented lead-acid battery is a cell in which the products of electrolysis and evaporation are allowed to escape to the atmosphere as they are generated. Synonym: flooded cell.

Statement of Problem and Substantiation for Public Comment

Vented lead-acid and nickel-cadmium batteries are being considered as excluded from standby power requirements as covered in Public Comment 121 and TG 24 recommendations. This definition is needed to ensure that AHJ's and regulatory bodies understand the distinction of a vented lead-acid cell (or vented nickel cadmium cell) from the more common VRLA or 'sealed' nickel-cadmium batteries. Note: This ties into FR 126.

Related Item

- FR 126; PC 121

Submitter Information Verification

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Committee:	ESS-AAA

Public Comment No. 173-NFPA 855-2024 [New Section after A.9.6.3.2.1]

A9.6.4

Where significant amounts of Lithium-Ion-Batteries have burnt and a water based extinguishing system has been activated, the waste water is likely to be contaminated with heavy metals and organic components.

The handling of this waste water should be adjusted to the location of the energy storage system. Where sensitive nature and organisms are present the water from fixed fire fighting systems for the expected operation time should be collected.

Statement of Problem and Substantiation for Public Comment

Where significant amounts of Lithium-Ion-Batteries have burnt and a water based extinguishing system has been activated, the waste water is likely to be contaminated with heavy metals and organic components.
The handling of this waste water should be adjusted to the location of the energy storage system. Where sensitive nature and organisms are present the water from fixed fire fighting systems for the expected operation time should be collected.

Related Item

- 9.6.4*

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Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]

A.9.6.6.1.5.4

Possible standards to which combustible gas detectors might be approved or listed include UL 2075 (or ULC-Can-S588, IEC 60079-29-1, FM6320, and FM 6325. Possible standards to which toxic gas detectors might be approved or listed include IEC 62990-1, FM 6340 or UL 2075 (or ULC-Can-S588).

The purpose of ~~the~~ a combustible or hydrogen gas detector (if used) is to initiate ventilation that will remove flammable/explosive gases from the installation area before ~~a~~ an explosive or flammable atmosphere is reached. The purpose of toxic gas detectors (when used) is to either initiate fire suppression system response, initiate ventilation system response, or to warn personnel not to enter the space without SCBA. Note that for most lead-acid and Ni-Cd installations, calculated hydrogen release under normal float charging or even boost charging is relatively small and easily handled by normal occupancy type ventilation requirements, therefore use of a hydrogen detector for these spaces is often not even recommended (see IEEE 1635/ASHRAE 21). If a gas detector is used, its selection and location should be analyzed with the following considerations:

(1) Detected gas

(2) Response time

(3) Ambient airflow

(4) Vulnerability to fouling, poisoning, or drift

(5) Required maintenance

Detected Gas. ~~The detector should be selected to sense hydrogen since this is~~ Combustible gas detectors may specifically only sense hydrogen, or they can be a generic combustible sensor that senses for both hydrogen and a broader range of hydrocarbons (such as methane, etc.). Hydrogen is the only flammable gas that aqueous batteries (e.g., lead-acid, Ni-Cd, Ni-Zn) release under normal operation. Nonaqueous technologies, like lithium-ion ~~and NaNiCl~~, do not normally release gas except for under thermal runaway conditions (for those capable of being driven into thermal runaway). Li-ion batteries typically release a mix of toxic and combustible gasses; however, for combustible sensing purposes a hydrogen only sensor will suffice because that is the primary combustible-only gas released (carbon monoxide is released in greater quantities than hydrogen and is flammable but is typically considered a toxic gas instead). Toxic gas detectors are typically not needed for aqueous battery technologies because most of them do not release toxic gasses, even under thermal walkaway conditions, and if they do it is in minute amounts typically far below the IDLH. Toxic gas detectors may provide value in Li-ion installations. Early detection of toxic trace gases by appropriately placed high-sensitivity sensors that activate fire suppression systems can limit propagation of a thermal runaway event in some circumstances. Since carbon monoxide is the toxic gas of highest concentration released in a Li-ion thermal runaway event, and because sensing technology for carbon monoxide is ubiquitous and relatively advanced, sensing for carbon monoxide at higher concentrations may be used to activate ventilation systems or warn personnel not to enter a space without adequate PPE. See 9.6.6.6 for ventilation recommendations for abnormal conditions like thermal runaway.

Response Time. The detector should be selected to minimize the response time to initiate ventilation. Factors that can impact response time include the distance for the air–gas mixture to travel to the detector, the length of the sample tube (if applicable), the type of detector, and the analysis process. Detectors can be listed with response times of under a minute to several minutes. Because hydrogen molecules—being small—disperse fairly quickly and spread relatively evenly throughout the environment, and because the alarming and action threshold is at 25 percent of the LFL (and the LEL is even higher than the LFL by at least a factor of 2), hydrogen sensors should be placed between 1 m to 2 m (3 ft to 6 ft) from the battery vents to avoid unnecessary alarms and in accordance with the battery manufacturer's instructions.

Ambient Airflow. There are several documents that provide qualitative guidance on the number and location of gas detectors in process areas (e.g., EN 60079-29-16-1), performance requirements of detectors for flammable gases (e.g., ISA TR84.00.07), and monitoring for hazardous material release (e.g., CCPS publication *Continuous Monitoring for Hazardous Material Releases*). These documents provide guidance on the most common approaches to gas detector placement, including target gas cloud and scenario-based monitoring.

Vulnerability to Fouling, Poisoning, and Drift. Note that not all combustible and toxic gas–sensing technologies are equal. Some are more sensitive than others to fouling (i.e., misreading and/or failure) from cross-contamination with other gases that might be present. Note that the largest quantities of gases produced during a lithium-ion fire are hydrogen, carbon monoxide, and carbon dioxide. The environment where the ESS is installed should be assessed to determine the likely presence of any other gases that could foul or poison a catalytic bead–type sensor or an electrochemical detector. The sampling tube size, where used, should consider particulate concentration in the ambient that could clog the tube if not maintained regularly. Some detectors must be "bump tested"—exposed to a small amount of the calibration gas—to ensure the sensor continues to sense the target gas at the desired concentration.

Required Maintenance. ~~All~~ Almost all gas detectors require routine maintenance to ensure continued proper function (there are a few on the market that self-calibrate) . The manufacturer's guidelines should be followed for regular calibration, bump testing (if needed), and sample tube cleaning. The recommended intervals for such maintenance vary from 1 to 12 months, depending on the type and manufacturer of the device. Designers and installers should ensure that end users are aware of the maintenance requirements and manufacturer's instructions. Calibration should only be conducted by qualified personnel, and only with the target gas. In addition to regular maintenance/calibration for most detectors, even if they are not fouled by contaminant gasses causing them to be ineffective, all gas sensors have a lifetime and must eventually be replaced. Typical sensor lifetimes vary from 2-20 years. Follow manufacturer recommendations and instructions for replacement of sensors .

Note that because hydrogen molecules are very small, they tend to disperse rapidly. Hydrogen will initially head to the ceiling. Research by NIST (see GCR-10-929), Sandia National Labs (see SAND2019-7454C), the Netherlands Institute for Safety (see IFV 20210209), and many others indicates that gas concentration will be detectable throughout the room over a reasonable time period; therefore, placement of the hydrogen sensors should be at an easily-accessible location in the battery area [within 2 m (6 ft) of the batteries] instead of near a high ceiling in order to facilitate the relatively frequent maintenance required for the sensors.

Statement of Problem and Substantiation for Public Comment

The annex material was meant to cover additional information on both toxic and combustible sensors but was previously very minimal on the toxic side. This text adds additional information about toxic gas detection and detectors. UL9540A testing of the only manufacturer of NaNiCl proved that essentially no toxic or combustible gasses were released even when attempting to force thermal runaway (which didn't happen), so this technology was removed from the mention of thermal runaway. Self-calibrating hydrogen detectors with lifetimes of over 10 years are now commercially available.

Sensor replacement was not previously discussed and should be (it could be argued that it is covered under following manufacturer maintenance recommendations, but it is felt that there should be more explicit guidance), so it was added.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 350-NFPA 855-2024 [Section No. H.1.2.6]	Annex H reference section for IEC standards referenced here
Public Comment No. 351-NFPA 855-2024 [Section No. H.1.2.13]	Annex H reference section for UL standard referenced here
Public Comment No. 352-NFPA 855-2024 [Section No. H.1.2]	Annex H reference section for FM Global standards reference here
Public Comment No. 350-NFPA 855-2024 [Section No. H.1.2.6]	
Public Comment No. 351-NFPA 855-2024 [Section No. H.1.2.13]	

Public Comment No. 352-NFPA 855-2024
[Section No. H.1.2]

Related Item

- CI-160

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Committee:	ESS-AAA

Public Comment No. 224-NFPA 855-2024 [Section No. A.9.6.6.6]

A.9.6.6.6

During failure conditions such as thermal runaway, fire, and abnormal faults, some ESSs, in particular electrochemical batteries and capacitors, begin off-gassing flammable and toxic gases, which can include mixtures of CO, H_2, ethylene, methane, benzene, HF, HCl, and HCN. Among other things, these gases present an explosion hazard that needs to be mitigated. Explosion control is provided to mitigate this hazard.

Explosion prevention methods used to mitigate flammable gas hazards, e.g., a combustible gas concentration reduction system, may also be effective in reducing toxic gas concentrations. An engineering analysis should be conducted to determine if toxic gas detection is required in addition to flammable gas detection. Toxic gas detection warning and alarm set points should align with the occupancy type and installation type. More conservative values may be necessary to ensure enough time is available for people to relocate to a place of safety in certain occupancies or communities.

Both the exhaust ventilation requirements of 9.6.6.1 and the explosion control requirements of 9.6.6.6 are designed to mitigate hazards associated with the release of flammable gases in battery rooms, ESS cabinets, and ESS walk-in units. The difference is that exhaust ventilation is intended to provide protection for flammable gases released during normal charging and discharging of battery systems since some electrochemical ESS technologies such as vented lead-acid batteries release hydrogen when charging.

In comparison, the 9.6.6.6 provisions are designed to provide protection for electrochemical ESSs during an abnormal condition, such as thermal runaway, which can be instigated by physical damage, overcharging, short circuiting, and overheating of technologies such as lithium-ion batteries, which do not release detectable amounts of flammable gas during normal charging and discharging but can release significant quantities of flammable gas during a thermal event.

Aqueous battery systems, if abused or neglected for long periods of time, can go into thermal walkaway. This condition is not to be confused with thermal runaway as seen in lithium-ion batteries. Much less heat and gas are produced *(see IEEE 1635/ASHRAE 21)*, so explosion control is not needed. Safety concerns are covered by ventilation requirements in 9.6.6.1. Thermal walkaway in aqueous batteries is typically prevented by use of temperature-compensated charging.

Statement of Problem and Substantiation for Public Comment

As Toxics are critical concern of the public, TG 6 on Toxics have been reviewing available information and best practice approach. Committee Input under CI 106, recommends a addition a new Annex chapter for evaluation criteria. As all Fire create toxics, Requiring evaluation in the code would place an undue burden on the industry that is not require for other industries in fire condition.

Related Item

- CI 106

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Public Comment No. 200-NFPA 855-2024 [Section No. A.9.6.6.6.3]

A.9.6.6.6.3

The requirement in 9.6.6.6.3 recognizes that with some cabinet designs that have low internal volume, the application of NFPA 69 might not be practical. It is possible that a quantitative explosion analysis is necessary to show there is no threat to life and safety. Therefor a NFPA 68 partial volume deflargration is required. For example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit-level and installation-level test identified in 9.1.5 will provide the test data referenced in 9.6.6.6.3, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet.

While NFPA 68 has been an approved method for explosion mitigation, it is no longer a singular approved method. It can be provided as a supplement of NFPA 69 solutions in certain high-risk applications. An NFPA 69 system doesn't gurantee that a deflagration cannot happen, but it should signifiaclty reduce the potential impacts by reducing the overall quanity of combustible gases. Pockets of gas that exceed the LFL especially at the point source of release and can ignite, thus creating a partial volume deflagration. NFPA 68 application If it is used as a supplementary explosion control option, then 9.6.6.6.4 would be required as a large-scale test. NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the combustion gases generated during the cell-, module-, and installation-level testing under UL 9540A must be used when applying an NFPA 68 solution. Where the ~~likelihood~~ unlikelihood for possible detonation may still exists, alternative solutions, such as an automatic door opening system, should be considered.

NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods:

(1) Control of oxidant concentration

(2) Control of combustible concentration

(3) Predeflagration detection and control of ignition sources

(4) Explosion suppression

(5) Active isolation

(6) Passive isolation

(7) Deflagration pressure containment

(8) Passive explosion suppression

Combustible gas concentration reduction can be a viable mitigation strategy for possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries. Gas detection and appropriate interlocks can be used based on appropriate evaluation under an NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL) 2 instrumented safety system rating.

Data on flammable gas composition and release rates, such as that included in UL 9540A fire and explosion testing, provide the information needed to design effective explosion control systems.

Statement of Problem and Substantiation for Public Comment

Removing NFPA 68 as an options requires some additional clarification in the annex notes concerning a partial volume deflagration.

Related Item

- FR 109

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Committee: ESS-AAA

Public Comment No. 294-NFPA 855-2024 [Section No. A.9.6.6.6.3]

A.9.6.6.6.3

The requirement in 9.6.6.6.3 recognizes that with some cabinet designs that have low internal volume, the application of NFPA 69 might not be practical. It is possible that a quantitative explosion analysis is necessary to show there is no threat to life and safety. For example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit-level and installation-level test identified in 9.1.5 will provide the test data referenced in 9.6.6.6.3, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet.

While NFPA 68 ~~has been an approved method~~ and NFPA 69 have been approved methods for explosion mitigation, ~~it is~~ they are no longer ~~a singular approved method. It can be provided as a supplement of NFPA 69 solutions in certain high-risk applications. If it is used as a supplementary explosion control option, then 9.6.6.6.4 would be required as a large-scale test. NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the~~ singular approved methods, as only both systems in combination can provide an adequate level of protection. The combustion gases generated during the cell-, module-, and installation-level testing under UL 9540A must be used when applying an NFPA 68 solution. ~~Where the likelihood for detonation exists, alternative solutions, such as an automatic door opening system, should be considered.~~

NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods:

(1) Control of oxidant concentration

(2) Control of combustible concentration

(3) Predeflagration detection and control of ignition sources

(4) Explosion suppression

(5) Active isolation

(6) Passive isolation

(7) Deflagration pressure containment

(8) Passive explosion suppression

Combustible gas concentration reduction can be a viable mitigation strategy for possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries. Gas detection and appropriate interlocks can be used based on appropriate evaluation under an NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL) 2 instrumented safety system rating.

Data on flammable gas composition and release rates, such as that included in UL 9540A fire and explosion testing, provide the information needed to design effective explosion control systems.

Statement of Problem and Substantiation for Public Comment

Based on the public comment PC-278 for 9.6.6.6.1 and the problem statement and substantiation given there, deflagration venting should be added to this section.

The comments about the risk of transition to detonation in BESS systems have been deleted for the following reasons:
Hydrogen and other highly reactive gases can transition to a detonation. This requires however, a substantial amount of pre-compression (in most cases above 10barg) ahead of the flame front in order to increase the temperature of the unburnt gases to levels conducive to AIT (auto ignition temperature). For gases such as LIB off-gases this can be achieved in confined structures channels and ducts without vents along the length of the structure. “Gas explosion handbook” (https://www.gexcon.com/brochures/gas-explosion-handbook/)” reports how a detonation in a 10m long wedge-shaped vessel with stoichiometric propane-air mixture, circular obstructions and open end was observed. The book also shows how the same vessel with vents distributed on the top plate (similar to BESS enclosures) drastically reduces the explosion pressure and hence eliminates the possibility of transition to detonation. A deflagration analysis of the ESS determines size and location of vents to maintain a pressure below the reported Pred which is in general below 0.5barg and thus far below a pressure range that would allow auto-ignition and transition to detonation.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 278-NFPA 855-2024 [Section No. 9.6.6.6.1 [Excluding any Sub-Sections]]	
Public Comment No. 289-NFPA 855-2024 [Section No. 9.6.6.6.1.1]	
Public Comment No. 292-NFPA 855-2024 [Section No. 9.6.6.6.3]	
Public Comment No. 293-NFPA 855-2024 [Section No. 9.6.6.6.5]	

Related Item

- FR-109

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Public Comment No. 347-NFPA 855-2024 [Section No. A.9.6.6.6.3]

A.9.6.6.6.3

The requirement in 9.6.6.6.3 recognizes that with some cabinet designs that have low internal volume, the application of NFPA 69 might not be practical. It is possible that a quantitative explosion analysis is necessary to show there is no threat to life and safety. For example, the cabinet design might be installed such that any overpressure due to ignition of gases and vapors released from cells in thermal runaway within the enclosure are released to the exterior of the enclosure. There should be no uncontrolled release of overpressure of the enclosure. All debris, shrapnel, or pieces of the enclosure ejected from the system should be controlled. The UL 9540A unit-level and installation-level test identified in 9.1.5 will provide the test data referenced in 9.6.6.6.3, which is necessary for verification of the adequacy of the engineered deflagration safety of the cabinet.

While NFPA 68 has been an approved method for explosion mitigation, it is no longer a singular approved method. It can be provided as a supplement of NFPA 69 solutions~~ in certain high-risk applications~~ . ~~If it is used as a supplementary explosion control option, then~~ ~~9.6.6.6.4~~ ~~would be required as a large-scale test.~~ NFPA 68 applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized, and provides criteria for design, installation, and maintenance of deflagration vents and associated components. NFPA 68 does not apply to detonations. Hydrogen accumulation in a confined space can lead to a detonation. For that reason, the combustion gases generated during the cell-, module-, and installation-level testing under UL 9540A must be used when applying an NFPA 68 solution. Where the likelihood for detonation exists, alternative solutions, such as an automatic door opening system, should be considered.

NFPA 69 applies to the design, installation, operation, maintenance, and testing of systems for the prevention of explosions in enclosures that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures by means of the following methods:

(1) Control of oxidant concentration

(2) Control of combustible concentration

(3) Predeflagration detection and control of ignition sources

(4) Explosion suppression

(5) Active isolation

(6) Passive isolation

(7) Deflagration pressure containment

(8) Passive explosion suppression

Combustible gas concentration reduction can be a viable mitigation strategy for possible accumulation of flammable gases during abnormal conditions for lithium-ion batteries. Gas detection and appropriate interlocks can be used based on appropriate evaluation under an NFPA 69 deflagration hazard study. NFPA 69 allows concentration to exceed 25 percent LFL but not more than 60 percent with reliable gas detection and exhaust interlocks as demonstrated by a safety integrity level (SIL) 2 instrumented safety system rating.

Data on flammable gas composition and release rates, such as that included in UL 9540A fire and explosion testing, provide the information needed to design effective explosion control systems.

Statement of Problem and Substantiation for Public Comment

If manufacturers / owners want to add additional safety measures such as NFPA 68, the code should encourage this instead of making it more difficult.

Related Item

- A9.6.6.6.1.5

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Public Comment No. 313-NFPA 855-2024 [Section No. A.15.13.1]

A.15.13.1

A UL 9540A ~~or equivalent~~ and UL 9540B test should evaluate the fire characteristics of the composition of gases generated at the cell, module, and unit and installation levels for ESSs undergoing thermal runaways, such as what might occur due to a fault, physical damage, or exposure hazard. The evaluation of the fire characteristics during fire vent testing at the unit-level and installation-level testing should document whether the fire event propagates to the neighboring ESS units and include radiant heat flux measurements at enclosing wall surfaces and at various distances from the ESS being tested at the unit level. The fire and explosion testing data is intended to be used by manufacturers, system designers, and AHJs to determine if the required separation distance for an ESS installation can be reduced.

Statement of Problem and Substantiation for Public Comment

1. Removes "or equivalent test report"
2. Adds UL 9540B, Outline of Investigation for Large-Scale Fire Test for Battery Energy Storage Systems. UL 9540B was developed to provide a standardized large-scale fire test method to evaluate the fire propagation characteristics of residential battery energy storage systems (BESS) .

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 95-NFPA 855-2024 [Section No. 15.13.1 [Excluding any Sub-Sections]]	

Related Item

- FR-102

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Public Comment No. 310-NFPA 855-2024 [New Section after B.1]

B1.2 New Technologies

The advancement of cell technologies and ESS types is rapid evolving. The standard provides a means for non specific technologies to be addressed throughout the standard. The following technologies are not considered all inclusive and as technologies are advanced, associated material testing, listing, and hazard analaysis must be conducted to support the product based on the standard.

Statement of Problem and Substantiation for Public Comment

TG8 reviewed many new technologies as part of the development process. The rapidly evolving technologies will be a topic for consideration over every cycle of NFPA 855. New technologies must have appropriate testing to understand the hazards associated with new chemistries and technologies. This new appendex language is intended to provided clarification that the technologies in appendix B is not all inclusive and technologies which do not have a specific callout would meet the "other chemistry" provisions.

Related Item

- FR7

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Submittal Date: Thu May 30 13:59:29 EDT 2024
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Public Comment No. 223-NFPA 855-2024 [New Section after B.4.4]

Annex B4.5- Toxic Emission Hazards

RECOMMENDATION to TOXICS and EMERGENCY RESPONSES TO BESS INCIDENTS

Due to increasing public attention on the potential toxic releases from BESS incidents, the following guidelines have been added to the appendix to help first responders make informed decisions.

Emergency responses to BESS incidents need to be viewed through the same lens as any fire response. The main priorities, in order of importance, for first responders are life safety, property safety and environmental safety. First arriving company officers need to use a C.A.N. report to organize the incident and set incident objectives. C.A.N. stands for Conditions, Actions and Needs. The Conditions section is the initial size-up. The Actions section is what the first in engines plan to do to address incident mitigation. The Needs section is reported to overhead to advise what additional resources and equipment are needed to successfully address incident objectives.

Upon arrival, crews need to make contact with site representatives to determine the location and nature of the fire incident. The type of technology involved in the incident will then determine next steps for mitigation efforts. As a rule of thumb, crews need to identify the extent of fire involvement and the location, next isolate the area and deny entry to non-essential personnel, and finally set up the incident command post upwind of the fire to manage the incident and stage incoming equipment. BESS fires have the same essential considerations as any structure fire and in fact, require less direct engagement of fire personnel which makes them ultimately safer to manage. The main objectives for first in engine companies are to: locate and evaluate of extent of the incident; to monitor threatened exposures from a safe distance and establish triggers for engagement of said exposures; to work with site personnel to set up operational objectives; and to manage downwind exposures for the duration of the incident.

About Plume Models:

It is recommended that the effects of toxic emissions be considered where there is potential for significant concentrations to be produced during a failure event. Plume dispersion modeling may be necessary to evaluate the consequences of various hazard scenarios. Plume modeling is performed to determine the extent of flammable and toxic gas dispersion, either unreacted or reacted gases, during a failure event. Plume models may be required by a utility, customer or AHJ to provide information about possible consequences of a release of material. Plume models may be used to understand potential first responder exposures, inform emergency response planning and/or provide information about potential environmental consequences. Plume models can inform minimum approach distance (MAD) and safe staging area locations.

Plume Modeling Methodology:

The individual performing the model should be well-versed in modeling advantages and limitations. Additionally, the individual should be familiar with the contents of the user guide, technical guide, and verification and validation documents for the model to ensure proper use of the model and application of modeling outputs.

Types of Plume Models:

Examples of models that can be used to evaluate plume dispersion are provided in the Table below. It is important the user be familiar with the limitations of each model. Large-scale event modeling is ever evolving, so it should not be assumed that the list is comprehensive or that listed models are being actively maintained by the developer.

Model Name	Domain (Cell Size)	Developed for	Physics
FDS	m- ~1-2 km, computationally expensive at km (cm-m, multi-mesh)	Multiple plume and combustion scenarios, chemistry only for CO, may not predict unsteady dispersion well	TKE+LES (CFD)
FLARE/ BUOYANT	Km (Determined automatically by CORINE, 100s m)	Forest or pool fire plumes, no phase changes in plume, no pollution, developed with HARMONIE (region locked to Finland)	Simple physics
HIGRAD/FIRETEC	~1 km, 100s ft to 10s mi. Computationally expensive (cm-m)	Wildfire- flame front, combustion	LES (CFD)
WRF-SFIRE-CHEM	km or larger, landscape scale. Limited to 10 m above ground (10s m, multi-mesh)	Wildfire- atmospheric physics/chemistry, smoke & gaseous product transport, focus on fire propagation. CHEM for chemistry of emissions and yields. Dependent on WRF data	Eulerian Simplified combustio focused or fireline/ atmospher
WFDS	~1 km, computationally expensive beyond 4 km (cm-m)	Wildfire- flame front, combustion, use WFDS-LS for fireline propagation	LES (CFD)
Meso-NH	10s m-km, micro & mesoscale (10s-100s m, multi-mesh)	Atmospheric physics/chemistry, has surface to atmosphere interactions, reliant on NWP databases (primarily European region locked)	TKE+LES
AERMOD	-	Atmospheric dispersion doesn't work well at low/complex wind speeds. No aerosol dynamics/plume rise. Uses AERMET for weather and AERMAP for terrain	Gaussian
ADMS	Up to 50 km (Up to 3000 grid cells)	Atmospheric dispersion doesn't work well at low/complex wind speeds. Averaged concentrations	Quasi-Gaussian
ANSYS Fluent	km (m)	Fluid dynamics with 3D modeling	RANS stea unsteady L (CFD)
CHIMERE	km, anything below 1 km is parameterized (10s km)	Atmospheric dispersion modeling w/ chemistry, PM tracking , large time steps (order of 0.5 days+)	-
CMAQ-Bluesky	1000s km (1-4~12 km, 1 km for finer)	Atmospheric dispersion modeling. Bluesky for emissions/yield	Eulerian
Daysmoke	~5 km (~100 m)	Extension of ASHFALL (sugar cane fire), no chemistry	Lagrangiar (simple physics)

PB-P	~1 km (~100 m)	Ground smoke transport at night over complex terrain	Lagrangian (simple physics)
ALOFT-FT	1000s m, 2D model (100s m)	Downwind distribution of smoke particulate/combustion products, flat terrain	-
SCICHEM	Variable resolution (1m – 100 m) receptor grids that can be out to 10s of km	Atmospheric dispersion modeling w/ chemistry, PM tracking	Lagrangian puff

Modeling Inputs:

The selection of scenarios should be based on the most likely failure conditions as well as the highest consequence failure conditions that are reasonably expected to occur. Modeled hazard scenarios should be derived from full-scale fire testing of the actual system, where possible, or experimental test data that is believed to accurately represent anticipated failure conditions. The model should consider dispersion created by a forced ventilation system that may be installed in accordance with NFPA 69. Modeling should consider the temperature of the gases and the heat release rate of a fire. Depending on expected failure conditions, separate plume models may be needed to account for fire and non-fire conditions. Plume modeling should include a probable worst-case scenario, which can be used for emergency planning.

Plume model results depend on weather conditions at the time of release. Plume models should use reasonable worst-case weather conditions, e.g., temperature and wind, based on historical weather conditions at the site. Alternatively worst-case conditions of wind at 10m at 1.5 m/s and class F stability may be used (Please provide reference). A bounding analysis should be performed when there is uncertainty regarding an input value.

Modeling Outputs:

The modeling should clearly show the extent of any hazardous exposures under varying wind and temperature conditions and identify any potential consequences extending outside site boundaries. For toxicity, the model output should provide the toxic gas components (or an equivalent toxic gas mixture) in ppm (or equivalent) as a function of time and distance from the source. For flammability, the model output should provide the flammable gas mixture in percent of LFL as function of time and distance from the source. Cloud shapes may be plotted for fixed values of toxic concentration and flammable concentration to identify hazardous areas and areas where ignition source control may be needed, respectively. Appropriate elevations shall be selected for model output given the objective of the analysis. For example, providing gas concentrations at 6-feet elevation may be appropriate when evaluating first responder safety whereas ground level concentrations may be appropriate for environmental assessments.

First responder use of plume studies:

A plume study can help to inform first responders of potential conditions during an emergency event. Like structure fire size-up to “read the smoke”, the plume and hazards related to the battery event will help identify the level of hazard that may be present on initial arrival. A worst case most probable scenario provides a starting point for monitoring and consideration for protective action. Ideally, the design basis failure should not require protective actions for the public located beyond the property line of the facility unless with prior approval by the AHJ. When the AHJ approves release levels that may require protective actions based on the design basis plume study, an Annex should be added to the regional emergency operating plan to address this hazard.

Monitoring the plume model will help first responders identify starting points for immediate and follow-up monitoring. At minimum, first responders should consider monitoring for CO, LFL, and HF.

Exclusion Zones:

The AHJ may require that the HMA identify the Exclusion Zones . The Zones are typically given as the distance from the perimeter of or failure point in an ESS beyond which exposure to heat, pressure, and toxic gases present a minimal risk to those with no PPE. The Exclusion Zones are a theoretical estimation; actual conditions present during an event may warrant shorter or longer approach distances.

Plume models may be used to inform the Exclusion Zones to be used during emergency incidents. The Exclusion Zones should be at a distance at which the concentrations generated by the plume are not expected to exceed the OSHA PEL or ceiling limits. If the incident is expected to last a long time, then the concentration could be based on longer time period exposures and the distance may be increased.

Statement of Problem and Substantiation for Public Comment

As Toxics are critical concern of the public, TG 6 on Toxics have been reviewing available information and best practice approach. Committee Input under CI 106, recommends a addition a new Annex chapter for evaluation criteria. As all Fire create toxics, Requiring evaluation in the code would place an undue burden on the industry that is not require for other industries in fire condition.

Related Item

- CI 106

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Public Comment No. 92-NFPA 855-2024 [Section No. B.5.7.1]

B.5.7.1 Sodium Batteries, High-Temperature — General Description.

High-temperature sodium batteries, sometimes referred to as *sodium beta batteries* or *molten salt batteries,* ~~are hermetically sealed batteries with~~ contain hermetically sealed battery cells with metallic sodium as the negative electrode and a ceramic beta-alumina as the electrolyte. These batteries operate at high temperatures of 500°F to 698°F (260°C to 370°C) so that the active materials are in a molten state and to ensure ionic conductivity. There are two types of commercially available high-temperature sodium batteries: sodium sulfur and sodium nickel chloride. Sodium sulfur ~~batteries consist~~ battery cells consist of a sodium negative electrode, a beta-alumina electrolyte, and a sulfur positive electrode with an operating temperature within a temperature range of ~~590°F~~ 572°F to 698°F (~~310°C~~ 300°C to 370°C). Sodium nickel chloride batteries consist of a sodium negative electrode, a beta-alumina as the electrolyte, and a positive electrode that could consist of nickel, nickel chloride, or sodium chloride with an operating temperature range of 500°F to 662°F (260°C to 350°C).

B.5.7.1.1 Sodium Sulfur (Na-S) Batteries.

Hazard considerations for Na-S batteries under normal operating conditions are as follows:

(1) *Fire hazards*: The potential exists for fire hazards if there are latent defects within the cells or design issues with the controls ~~that prevent~~ which are supposed to prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects.

(2) *Chemical hazards*: Not applicable. The batteries contain water-reactive sodium, but the ~~systems are~~ system cells are hermetically sealed.

(3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.

(4) *Stranded or stored energy hazards*: The potential exists for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance.

(5) *Physical hazards*: There should be no hazards associated with these batteries if the designs have sufficient insulation to prevent exposure to hot surfaces, because these batteries run at very hot temperatures under normal operating conditions.

Hazard considerations for Na-S batteries under emergency/abnormal conditions are as follows:

(1) *Fire hazards*: These systems might be subject to thermal runaway due to defects within the cells and protection scheme. Large energy systems can result in fires if there are abnormal conditions such as short-circuiting.

(2) *Chemical hazards*: The potential exists for exposure to hazardous water-reactive materials if the hermetic seals are broken and sodium is exposed to the atmosphere. PPE is required to address exposure during abnormal conditions.

(3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.

(4) *Stranded or stored energy hazards*: The potential exists for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Technicians should follow accepted procedures when working on these batteries where these batteries are subjected to abnormal conditions.

(5) *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating.

B.5.7.1.2 Sodium Nickel Chloride Batteries.

Hazard considerations for sodium nickel chloride batteries under normal operating conditions are as follows:

(1) *Fire hazards*: The potential exists for fire hazards if there are latent defects within the cells or design issues with the controls that prevent thermal runaway of the cells. Systems need to be evaluated for their ability to prevent propagation due to these defects.

(2) *Chemical hazards*: Not applicable. Although sodium is water reactive, the systems are hermetically sealed and will not release any material during normal operation.

(3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. Technicians should follow accepted maintenance and installation procedures when working on these batteries.

(4) *Stranded or stored energy hazards*: The potential exists for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance. Technicians should follow accepted maintenance and installation procedures when working on these batteries.

Availability of stored energy is based on internal temperature. Once internal temperature drops below the minimum operating temperature, typically 500°F (260°C), any energy stored or stranded becomes electrically unavailable external to the module. The battery will then slowly release its heat energy at approximately the 100W rate. When the internal temperature drops below the solidification or freezing point of the active materials [approximately 302°F (150°C)], the release of any stored or stranded electrical energy is no longer possible. The electrical energy will not become available again until the heat energy is replaced from an external source.

(5) *Physical hazards*: There should be no hazards associated with these batteries if the designs have sufficient insulation to prevent exposure to hot surfaces, because these batteries run at high temperatures under normal operating conditions. There might be a lifting hazard due to the weight of the battery, which is only an issue during installation, replacement, or removal.

Hazard considerations for sodium nickel chloride batteries under emergency/abnormal conditions are as follows:

(1) *Fire hazards*: These systems might be subject to thermal runaway due to defects within the cells and protection scheme. Large energy systems can result in fires if there are abnormal conditions such as external short-circuiting.

(2) *Chemical hazards*: The potential exists for exposure to hazardous water-reactive materials if the hermetic seals are broken and sodium is exposed to the atmosphere. PPE is required to address exposure during abnormal conditions.

(3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels. Technicians should follow accepted procedures when working on these batteries subjected to abnormal conditions.

In most cases, these hazards will be mitigated because the electrical energy will be isolated from external power terminals during alarm or fault conditions. The battery will then slowly release its heat energy at approximately the 100W rate. When the internal temperature drops below the solidification point (i.e., freezing) of the active materials [approximately 302°F (150°C)], the release of any stored electrical energy is no longer possible.

(4) *Stranded or stored energy hazards*: The potential exists for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they could still contain hazardous levels of energy. Technicians should follow accepted procedures when working on these batteries subjected to abnormal conditions.

Availability of stored energy is based on internal temperature. Once internal temperature drops below the minimum internal operating temperature, typically 500°F (260°C), any energy stored or stranded becomes electrically unavailable external to the module. The battery will then slowly release its heat energy at approximately the 100W rate. When the internal temperature drops below the solidification point (i.e., freezing) of the active materials [approximately 302°F (150°C)], the release of any stored or stranded electrical energy is no longer possible. The electrical energy will not become available again until the heat energy is replaced from an external source.

(5) *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating.

Statement of Problem and Substantiation for Public Comment

In NAS battery system, the cells that are sealed, not the entire system.

Please check the safety-related documents at the link: https://web.tresorit.com/l/SonJ0#lRHsZkJsbEu-m16bSfnEow

Related Item

- FR-146

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Public Comment No. 86-NFPA 855-2024 [Section No. B.5.8]

B.5.8 Nickel Hydrogen.

In rechargeable nickel-hydrogen batteries under charge conditions, the nickel hydroxide becomes nickel-oxide-hydroxide and hydrogen. During discharge the hydrogen is recombined with the nickel-oxide-hydroxide to give nickel hydroxide. The amount of hydrogen generated is a fixed amount that is a function of the amount of nickel hydroxide.

Hazard considerations for nickel-hydrogen batteries under normal operating conditions are as follows:

(1) *Fire hazards*: Thermal runaway not noted during testing~~.~~

(2) *Chemical hazards*: Not applicable.

(3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.

(4) *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards during maintenance if the batteries cannot be isolated for maintenance or replacement.

(5) *Physical hazards*: Not applicable.

Hazard considerations for nickel hydrogen under emergency or abnormal conditions are as follows:

(1) *Fire hazards*:~~ Thermal runaway not noted during testing.~~ - .During a thermal runaway, an off-gassing event occurs, due to the lack of combustible materials or flammable components no ignition or flame is possible during thermal runaway.

(2) *Chemical hazards*: None indicated.

(3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.

(4) *Stranded or stored energy hazards*: There can be the potential for stranded or stored energy hazards if the batteries are exposed to abnormal conditions where they might still contain hazardous levels of energy. Damaged batteries might contain stored energy that can be a hazard during disposal if care is not taken.

(5) *Physical hazards*: Depending on the design of the system, the potential exists for physical hazards under abnormal conditions if accessible parts are overheating or if there is exposure to moving hazardous parts, such as fans where guards might be missing.

Statement of Problem and Substantiation for Public Comment

This revision is intended to clarify the hazard associated with abnormal fire conditions with this chemistry. This chemistry type was added in the first revision and additional clarification was needed.

Related Item

- FR-10

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Public Comment No. 227-NFPA 855-2024 [Section No. G.6.1.5]

G.6.1.5 Inerting. ~~(Reserved)~~

Inerting suppression systems can extinguish battery fire and prevent propagation of thermal runaway when used in accordance with engineered design concentrations. Gas concentration shall be maintained for a period sufficient enough to prevent reignition before the space is accessed. The hazard event gas levels and temperatures inside the ESS should be monitored to provide information regarding the ambient conditions inside the ESS. Pressure relief venting shall be installed where appropriate for the protected ESS. Purging of the protected space shall be done with a regular venting system, HVAC system or a manual discharge of a secondary inerting system before the ESS is accessed by personnel.

Statement of Problem and Substantiation for Public Comment

In the right scenario, inerting suppression systems can extinguish a battery fire when deployed in a high enough volume and can prevent propagation of thermal runaway from damaged cell/module to nearby cell/modules. Oxygen produced by an off-gassing cell does not produce sufficient oxygen to sustain fire on its own and would require supplemental oxygen from the environment. Once the oxygen in the ESS is depleted or reduced to a level low enough through inerting, even oxygen produced by a cell in thermal runaway will not provide enough oxygen to ignite into flame.

(information from Ofodike Ezekoye PhD,PE 's prensentation:

https://players.brightcove.net/1640544031001/default_default/index.html?videoId=6341563316112

and KIT Report:

https://www.ffb.kit.edu/download/IMK%20Ber.%20Nr.%20192%20Kunkelmann%20Lithium-Ionen-%20und%20Lithium-Metall-Batterien%20Brandbekaempfung.pdf)

Based on comment to add back in NFPA 2001, 12, 2010, 770; it is appropriate to add more language into the Annex G regarding inerting systems.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 250-NFPA 855-2024 [Section No. A.4.9.3.2]	
Public Comment No. 277-NFPA 855-2024 [Section No. 4.9.3.2]	

Related Item

- FR-45 4.9.3.2,

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Public Comment No. 104-NFPA 855-2024 [Section No. G.6.1.6]

G.6.1.6 Aerosols.

Aerosol suppression systems can extinguish a fire but will not stop thermal runaway or off-gassing if the cells are damaged, which creates a potentially explosive environment. If gas is allowed to accumulate, a more hazardous condition can develop. There might be times that venting is more critical than suppression. If the gas detection system continues to see increasing levels of combustible gas or toxic gases during suppression, venting might be required through either a direct tie to the gas detection system or a manual operation to begin venting. The suppression systems might not have reached their hold times yet and agent might be vented. Even if the fire has been extinguished and hold times have been met, the gas detection system should still be monitored in case of any subsequent events, including reflash due to stranded energy. Venting might be required at a later point as well.

~~EN 15276-1 and EN 15276-2 state that condensed aerosols are not to be used on fires involving the following~~
Aerosol systems are not recommended for use on the following hazard categories unless based on reports issued as a result of fire and explosion testing in accordance with section 9.1.5 :

(1) Chemicals containing their own supply of oxygen (e.g., cellulose nitrate)

(2) Mixtures containing oxidizing materials (e.g., sodium chlorate, sodium nitrate)

(3) Chemicals capable of undergoing autothermal decomposition (e.g., some organic peroxides)

(4) Reactive metals (e.g., sodium, potassium, magnesium, titanium, zirconium), reactive hydrides, or metal amides, some of which can react violently with the extinguishants

(5) Oxidizing agents (e.g., nitric oxides and fluorine)

(6) Pyrophoric materials (e.g., white phosphorous, metallo-organic compounds)

The above list is not exhaustive. ~~Items (3) and (5) are applicable to lithium-ion batteries.~~

G.6.1.6.1 Standards.

For more information on aerosol systems, see the following:

(1) NFPA 2010

(2) *NFPA 70*

(3) *NFPA 72*

(4) ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units*

(5) International Code Council IFC and IBC standards

G.6.1.6.2 Listing.

G.6.1.6.2.1

The fire extinguishing agents addressed in this standard should be listed in the US EPA SNAP list for use as a total-flooding fire-extinguishing agent in occupied and unoccupied spaces.

G.6.1.6.2.2

Aerosol systems and automatic aerosol units should be listed for service at ambient operating temperatures of the LIB ESS facility where they are installed.

G.6.1.6.2.3

All aerosol systems and automatic extinguishing units should comply with ANSI/UL 2775.

G.6.1.6.3 Design and Installation.

Aerosol systems for ESS applications can be electrically operated or manually released with a fire alarm control system meeting *NFPA 72* and *NFPA 70* requirements. Multiple electric operated aerosol extinguishing units can be wired in series or in parallel to the fire alarm control panel and in accordance with NFPA 2010. System design should meet listing requirements, NFPA 2010, and ICC IFC/IBC standards.

G.6.1.6.3.1

Aerosol quantities for the protection of ESS applications should be based on the calculation methods described in NFPA 2010.

G.6.1.6.3.2

ESS enclosure integrity and uncloseable opening aerosol leakage impact on aerosol density should be compensated in accordance with the methods and design factor calculations described in NFPA 2010.

G.6.1.6.3.3

ESS open loop ventilation systems should be shut down or ventilation dampers closed prior to activation of the aerosol units.

G.6.1.6.3.4

All aerosol systems and automatic extinguishing units should be installed and used to protect ESS hazards within the limitations of and in accordance with their listing or as designated by a fire and explosion fire test.

G.6.1.6.3.5

Electrically operated aerosol systems installed for the protection of ESSs during transit can be fitted with a battery-operated detection and aerosol control system. ESSs in remote locations with no primary source of AC power can be fitted with a battery-operated detection and aerosol control system.

G.6.1.6.3.6

Automatic aerosol units for ESS applications can be stand-alone extinguishing units provided the units have sufficient capacity to flood the ESS enclosure to the minimum design density for extinguishing Class A (surface), Class B, or Class C fires in accordance with the listing.

G.6.1.6.4 Testing.

If aerosol suppression is used as the primary fire suppression method and is not backed up by a water-based sprinkler system designed per the requirements of NFPA 855 or with a fire and explosion test meeting the specifications of the sprinkler section in this annex, a fire and explosion test should be conducted using the proposed ESS arrangement with the aerosol protection criteria proposed. Such a test should meet the same criteria as the sprinkler testing criteria listed and also dictate the required hold time for the anticipated thermal runaway event.

G.6.1.6.5 Inspection, Testing, and Maintenance.

Aerosol system and automatic aerosol unit inspection, testing, and maintenance requirements should comply with listing and manufacturer guidance described in the product design, installation, operation, and maintenance manual.

Statement of Problem and Substantiation for Public Comment

The language included would be consistent with section 4.9.3.1 where by an aerosol system would be allowable under the testing requirements of 9.1.5. With this new verbiage, reference to EN standards is not necessary.

Further, statement that items 3 and 5 are applicable to lithium ion batteries is:
1. not necessary
2. distract from the fact that this standard is intended to address multiple battery technologies. There is no need to call out which specific items are applicable to a specific battery technology.

Related Item

- Consistency with other sections in the 855 document

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Public Comment No. 209-NFPA 855-2024 [Section No. G.6.1.6 [Excluding any Sub-Sections]]

Aerosol suppression systems can extinguish a fire but will not stop thermal runaway or off-gassing if the cells are damaged, which creates a potentially explosive environment. If gas is allowed to accumulate, a more hazardous condition can develop. There might be times that venting is more critical than suppression. If the gas detection system continues to see increasing levels of combustible gas or toxic gases during suppression, venting might be required through either a direct tie to the gas detection system or a manual operation to begin venting. The suppression systems might not have reached their hold times yet and agent might be vented. Even if the fire has been extinguished and hold times have been met, the gas detection system should still be monitored in case of any subsequent events, including reflash due to stranded energy. Venting might be required at a later point as well.

~~EN 15276-1 and EN 15276-2 state~~ NFPA 2010 states that condensed aerosols are not to be used on fires involving the following:

- ~~Chemicals containing their own supply of oxygen (e.g., cellulose nitrate)~~
- ~~Mixtures containing oxidizing materials (e.g., sodium chlorate, sodium nitrate)~~
- ~~Chemicals capable of undergoing autothermal decomposition (e.g., some organic peroxides)~~

~~Reactive metals (e.g.~~ (1) Deep-seated fires in Class A materials
(2) Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air

(3) Reactive metals such as lithium , sodium, potassium, magnesium, titanium, zirconium

~~)~~

,

~~reactive hydrides, or metal amides, some of which can react violently with the extinguishants~~

- ~~Oxidizing agents (e.g., nitric oxides and fluorine)~~

~~Pyrophoric materials (e.g., white phosphorous, metallo-organic compounds)~~
uranium, and plutonium

(4) Metal hydrides

(5) Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxides and hydrazine

The above list is not exhaustive. ~~Items (3) and (5) are applicable to lithium-ion batteries.~~

Statement of Problem and Substantiation for Public Comment

Remove statement "Items (3) and (5) are applicable to lithium-ion batteries.". This clause is not part of the quoted standard.

Remove reference to EN standard and replace with NFPA 2010 section that covers the exclusions added to the text.
None of the above exclusions are related to Lithium ion cells thermal runaway fire hazard.
To address the comment that two of the exclusions included in EN15276 are related to lithium ion batteries:

1. The autothermal decomposition in Li-Ion batteries is a “mild” reaction and not the same as found with organic peroxides.
The chemical thermal runaway involves an exothermic reaction which is accelerated by its temperature rise, whereas the autothermal decomposition involves the rate of heat evolution which exceeds that of

heat loss thus increasing reaction temperature and rate. Examples of autothermal decompositions include the decomposition of the very reactive organic peroxides that can lead to highly explosive peroxidic residues, and the decomposition of nitric oxides that takes place at elevated temperatures or pressures.

2. The decomposition of the solid electrolyte interphase and the cathode (which takes place at low temperature) releases limited oxygen levels not capable of causing and sustaining auto-ignition. This phenomenon can not be compared to the rapid oxidation that occurs to chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder.

As per our extensive tests (information provided in Public Comment No. 205-NFPA 855-2024) the fire hazards related to lithium ion cells thermal runaway (even in different cell technologies) consist of Class A (Combustibles, i.e. Polymeric housing material of the cells) + Class B (Flammable liquids, i.e. Electrolyte and Off-gases) + Class C (Electrical Equipment, i.e. Energized Electrical Equipment).

Finally, exclusions should be included for all technologies, as listed in the appropriate NFPA codes.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 205-NFPA 855-2024 [Section No. 4.9.3.2]	NFPA 2010 reference

Related Item

• SR-67-NFPA 855-2021 • PC-81-NFPA 855-2021

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Public Comment No. 120-NFPA 855-2024 [Section No. G.7.3.6.1]

G.7.3.6.1 Cell-Level Event.

Battery cells will release flammable gases throughout the cell venting (also known as off-gassing) and thermal runaway stages of failure; however, the species composition, release rate, and temperature will vary based on the phase. Ideally, during cell venting, the battery's safety features are activated, leading to the release of gas and other reactive materials in a controlled manner to prevent an uncontrolled explosion. ~~In this scenario, the gas species primarily consists of carbon dioxide (CO_2), carbon monoxide (CO), hydrogen (H_2), and VOCs.~~ The gas temperature during cell venting is generally around 100°C –150°C (212°F – 302°F).

During ~~cell~~ thermal runaway, the ~~battery~~ cell undergoes a rapid, self-sustaining increase in temperature. In ~~this situation~~ thermal runaway , additional flammable and toxic gas species might be produced, including hydrogen fluoride (HF), hydrogen cyanide (HCN), various hydrocarbon gases (e.g., CH_4, C_2H_4, C_2H_6, and so forth), in addition to those gases produced during cell venting. The gas temperature during thermal runaway can reach much higher levels, often exceeding 500°C (932°F), resulting in the rapid release of large volumes of flammable or toxic gases, posing a significant hazard to human health and the environment.

Off-gas detection ~~in the early stages~~ , during cell venting, might target different gas species than ~~that during~~ those during cell thermal runaway. In all cases, the detection method should be tied to the cell chemistry, sensor location relative to the cell(s), volume of the enclosure (i.e., a cabinet or a large room), and objective of detection to ensure that the sensor is aligned with the safety objectives. Technologies are advancing rapidly; however, early and rapid detection must also be paired with response, thus ~~costly~~ systems that can provide some level of advanced notice might not provide a significant increase in ~~actions or~~ improved safety outcomes ~~. In contrast to smoke detectors in occupied structures, knowledge of a cell failure several minutes earlier might not result in any difference in outcome unless the detection system is also tied into a viable thermal runaway protection system that stops the event.~~ unless tied to a thermal runaway prevention system.

Gas detection, close to or inside the affected module (cell level detection), has proven to be a reliable means of pre-thermal runaway warning. Off-gas sensors or detectors installed at the battery rack level are capable of sensing the off-gas byproducts from a single cell. The early detection of thermal runaway has also proven that a cell can be disconnected, effectively stopping the overheating process and preventing thermal runaway. Off-gas detection systems of various types have been shown to be effective at detecting cell failure prior to thermal ~~runaway—in~~ runaway, in some cases as much as 30 minutes prior. ~~However, this advanced knowledge must be tied into other mitigation systems to prevent thermal runaway from occurring or propagating.Off-gas~~

Off-gas sensors or detectors are typically mounted in each battery rack or module, with the exact location of the sensors or detectors being dictated by the actual rack design. But, in general, the sensors must be mounted in the path of airflow. This could mean that, depending upon rack design, the sensor or detector could be either at the top or bottom of the rack. For specific detection design requirements, refer to the manufacturer's published installation and operation manuals and any relevant regulatory approvals/listings for the intended purpose of "off-gas detection" from the incipient stages of a lithium-ion battery thermal runaway.

Gas, in the early stages of thermal runaway events, will be colder than ~~off-~~ gas in the later stages. The gas produced early ~~off-gas~~ on can therefore become heavier than the air, collecting at floor level. It should therefore be considered if gas detection related to room explosion risks should be applied at both levels, close to the floor and close to the ceiling. Both sensor and ASD detection technologies can provide off-gas detection in the early stages of lithium-ion battery thermal runaway events. In addition to off-gas detection, ASD detection can provide very early smoke detection.

~~Tests conducted in this project indicate that solely relying on lower explosion limit (LEL) sensors and cell voltage levels to detect early stages of a thermal runway event is insufficient.~~

~~Cell-level detection, close to or inside the affected module, has proven the most reliable means of pre-thermal-runaway warning. The early detection of thermal runaway has also proven that a cell can be disconnected, effectively stopping the overheating process.~~

~~One important aspect of the protection of LIB systems in ESSs is the prevention of thermal runaway and propagation of cell failures. While there are many ways to detect and prevent thermal runaway, off-gas monitoring or off-gas particle detection is, perhaps, the most effective~~

~~because it provides the most amount of time to react to the condition.~~ Off-gas ~~monitors or detectors are installed at the battery rack level and capable of sensing the off-gas byproducts from a single cell. In this way, they can provide up to 30 minutes of time for investigation and intervention by automatic deactivation of charging before thermal runaway.Off-gas~~ sensors or detectors must be designed to detect the variety of different gases from the many types of LIB chemistries. The gases emitted during the early stages of battery failure are a precursor to the much larger and more dangerous issue of thermal runaway and potential propagation of fire from cell to cell and module to module. This is why, for thermal runaway prevention, LEL gas detectors are not adequate because the concentrations of flammable gases are not high enough. Flammable gas detection has a role to play in other aspects of the protection of the ESS *(see 9.6.6.6)*.

~~Off-gas sensors or detectors are typically mounted in each battery rack or module, with the exact location of the sensors or detectors being dictated by the actual rack design. But, in general, the sensors must be mounted in the path of airflow. This could mean that, depending upon rack design, the sensor or detector could be either at the top or bottom of the rack. For specific detection design requirements, refer to the manufacturer's published installation and operation manuals and any relevant regulatory approvals/listings for the intended purpose of "off-gas detection" from the incipient stages of a lithium-ion battery thermal runaway.~~

To be most effective, the network of sensors or detectors throughout the many battery racks in the ESS must be connected with a central controller that allows for the supervision for failures of the individual sensors and a coordinated response when one or more sensors or detectors detect an off-gas event. The responses can be either automated or human generated.

Statement of Problem and Substantiation for Public Comment

Section G.7.3.6.1 was reorganized for clarity by reordering paragraphs, removing redundant information, and using consistent terminology around cell venting and thermal runaway. At least one reference to cost was removed from the section since this is not appropriate for an installation standard. The overall meaning of the section remains the same.

Related Item

- FR-172

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G.8 Explosion Hazard Analysis and Mitigation for Lithium Ion ESS

G.8.1 Introduction.

This section assists authorities having jurisdiction (AHJs), stakeholders, and practitioners with engineering design and risk mitigation considerations to minimize the likelihood and consequences of an explosion event. This section does not prescribe how hazard and risk analyses are performed, rather it presents principles and methodologies to assist the energy storage practitioner in the qualitative and quantitative analysis process.

G.8.2 Essential Hazard Mitigation Analysis (HMA) Elements.

G.8.2.1 Probability and Consequence.

In the design of these systems, engineers must balance criteria for performance, cost, size, and safety concerns. Achieving a high level of safety is especially important in applications in densely populated environments, such as indoor installations, where a thermal-runaway event is more likely to lead to harm to occupants or result in high losses of the structure and property.

Typically, explosion risk is quantified by assessing probability of occurrence, consequences of the event, and detectability of the generation of flammable gases of an event. Although the probability of an explosion is low in compliant listed and labeled BESSs, the effects and consequences can be extremely high. The first key feature of an HMA is the identification and quantification of the explosive risks associated with the BESS design.

Explosions can occur wherever flammable gas is able to accumulate within its flammability limits in an enclosure. For an ESS, this could occur within a single rack enclosure, standalone enclosure, installation structure, or building.

Each lithium-ion battery chemistry presents unique explosive risks due to the complex nature of their failure mechanisms: they produce large volumes of flammable gases and produce sufficient oxygen to sustain exothermic reactions that can emit particles hot enough to ignite gases.

A comprehensive HMA should include an assessment of explosive risks of the ESS unit as well as the overall installation with site-specific considerations of exposures, property safety, and life safety.

Each HMA should consider the integrated benefits of the purposeful layering of complementary engineering and administrative controls hierarchy thereby building defense in depth controls to establish a mitigated consequence probability.

G.8.2.2 Hierarchy of Controls.

With each identified hazard quantified, the mitigation objectives and associated approaches can then be considered based on acceptable risk tolerance, feasibility, and the hierarchy of controls. Within the hierarchy of controls, explosion hazards can be managed by engineering controls and administrative controls.

Engineering controls should focus on reducing or eliminating the generation of combustible gas, reducing the accumulation or concentration of combustible gas, and managing consequences of a deflagration with structural design and appropriate siting to exposures, and administrative controls. Some available explosion risk mitigation strategies include flammable gas exhaust, deflagration venting, inerting, suppression, hardening, and increased standoff distance to personnel and assets.

Administrative controls might include the proceduralization of operator instructions enabling early detection and purposeful deenergization of systems exhibiting degraded performance, increasing the breadth and depth of the scheduling of routine periodic maintenance focusing on safety critical system performance, implementation of daily operator status of health checks, or any other purposeful operator interaction with the systems to increase visibility and early detection of abnormal system performance.

G.8.3 Engineering Controls Considerations.

G.8.3.1 Reducing the Probability of Combustible Gas Generation.

Detection and preventing the generation of combustible gas within BESSs should be the objective of all engineered energy storage systems.

The careful selection of the lithium-ion battery chemistry should be researched, considering cell failure propensity where the generation of combustible gas might require additional and costly mitigation measures.

Reliance on industry certifications for safe operations of OEM battery management systems (BMS) and thermal management systems has proven to not prevent thermal runaway events. Additional design considerations of the ESMS or critical safety control systems should include the ability to monitor state-of-health and performance of individual cells (e.g., voltage, current, temperature) and take compensatory measures to reduce overcharge, overdischarge, and overtemperature conditions resulting in the removal of the affected module or rack from service.

Once deenergized, additional administrative controls can be implemented and can include any verification measure, including corrective maintenance and removal from service.

G.8.3.2 Preventing or Reducing the Probability of Combustible Gas Accumulation.

The explosion potential can be eliminated or reduced by preventing the accumulation of combustible gas within the installation or product enclosure.

To reduce flammable gas accumulation at the installation, a well-designed combustible gas reduction (i.e., ventilation) system must be incorporated. Design trends within the energy storage market sector include several different and competing design philosophies. These designs range from containing the battery modules and off-gas in gas-tight enclosures leading directly to a safe area, without passing the battery room. Other approaches include opening battery rack enclosures to the battery compartment where off-gas can be diffused by a forced exhaust system of sufficient air changes per hours (ACH). Forced exhaust systems are typically designed in accordance with NFPA 69. Opening the access doors to the enclosure and flooding the container with environment thereby exposing the battery compartment directly to external environment is another method to meet the NFPA 855 explosion prevention and deflagration venting requirements.

G.8.3.3 Managing the Consequences of Deflagrations or Explosions.

A comprehensive ESS explosion hazard mitigation includes the purposeful management of the consequences of deflagration or explosion through the implementation of deflagration protection (NFPA 68) or explosion prevention (NFPA 69).

Each BESS equipment provider should conduct an explosion hazard analysis to quantify the risks (e.g., explosive pressures, direction, missile generation and projection, heat flux, fireball, and so forth) and hazards (e.g., personnel, equipment, and environmental safety) and validate proposed mitigation designs. The proposed mitigative designs should objectively demonstrate conservative and bounding scenarios where the engineering controls mitigate the hazards. These mitigation analyses can be in the form of maximum theoretical steady-state analysis or computations fluid dynamics (CFD) modeling.

When reviewing the computational fluid dynamics or other analyses performed, the designer, functional safety engineer, practitioner, and AHJ should consider other important elements are presented in the explosion hazard analysis: enclosure reaction force; enclosure geometry; enclosure internal surface area including partial volumes; surface area of internal structures; and flammable gas properties, including lower flammability limit (LFL), laminar flame speed, and maximum closed vessel deflagration pressure.

G.8.4 Engineering Controls and Practices for Explosion Hazard Mitigation.

G.8.4.1 Design Considerations.

The broad range of recent global energy storage market sector failures and fires require the functional safety engineer to consider multiple credible and probabilistic scenarios as part of the HMA. Probabilistic scenarios should include the relevant data generated in the UL 9540A cell and module test as a realistic option for failure resulting in fire or explosions. Analysis should also include common-cause or common mode failures that also include plausible scenarios where ignition sources might be evident. Conservatism should always be applied to ensure a safety margin.

G.8.4.1.1

Recommended failure scenarios to consider in an HMA include the following:

(1) *UL 9540A failure level*: One or more cells, modules, or units based on the test results. UL 9540A is designed to induce cell-to-cell propagation of thermal runaway and measure the resultant fire and explosion hazards.

(2) *Limited propagation failure*: Adds a safety margin to the UL 9540A test result. For example, if one cell failed with no propagation, then evaluate a three-cell failure—one on either side. If a module failed but did not propagate, then evaluate a three-module failure—one above and below.

(3) *Twenty-five percent LFL failure*: Determine how may cells it takes to reach 25 percent LFL in the enclosure. This might overlap with another design scenario.

(4) *Partial volume deflagration*: Determine how many cells can fail with a resulting deflagration that does not produce a pressure value that will cause the enclosure to fail.

(5) *Worst total failure*: Assume all cells in the ESS fail.

G.8.4.2 Combustible Gas Venting Pathway.

If the lithium battery releases gas under pressure, there are a number of determining factors that influence the release rates and initial geometry of the escaping gases. The pressurized gas is released as a gas jet and, depending on the nature of the failure, might be directed by the module cooling system exhaust pathway. Escaping gases are normally very turbulent and air will immediately be drawn into the mixture. The mixing of air will also reduce the velocity of the escaping gas jet. Obstacles such as the module racking system, cable trays, conduit, HVAC ducting, buswork, structures, and so forth, will disrupt momentum forces of any pressurized release thereby adversely impacting turbulent burning velocities.

BESS designs that include obstructions (e.g., conduit and piping arrays, internal obstructions) within the combustible gas venting pathway can have a significant impact on flame speed and enclosure pressures due to the turbulence generated during the flow of unburned gas over and around the obstacles. In the likely event of igniting of the combustible gas, the flame front surface area is increased as a function of the obstacle surface area resulting in increased pressure transients.

If the release of combustible gas is not detected or ignited, the gas will generally form a vapor cloud that will be distributed throughout the BESS enclosure through mechanical ventilation or would naturally disperse in the atmosphere. Once the combustible gas reaches the flammability limits and is exposed to an ignition source, an explosive blast will occur. The resultant turbulent dispersion processes will be prevalent (e.g., high pressure flow, winds, congestion, and so forth), the gas will spread in both horizontal and vertical dimensions while continually mixing with available oxygen in the air. Initially, escaping gases are above the UEL, but with dispersion and turbulence effects, they will rapidly pass into the flammable range. If not ignited and given an adequate distance for dilution by the environment, they will eventually disperse below the LEL. Various computer software programs are currently available that can calculate the turbulent gaseous jet dispersion, downwind explosive atmospheric locations, volumes for any given combustible commodity, release rates, and atmospheric date input (i.e., wind direction and speed).

G.8.4.3 Combustible Gas Reduction System.

To design a combustible gas reduction system, the properties of the combustible gas must be known or assumed. The major components of a lithium-ion battery gas thermal runaway are typically hydrogen, carbon monoxide, carbon dioxide, and various hydrocarbons. While lithium-ion battery failures can result in differing gas compositions based on state of charge (SOC), gas release quantity is higher and flammability properties are more severe as SOC increases. Battery thermal runaway gas composition is characterized experimentally for 100 percent SOC under the cell-level test method of UL 9540A. This characterization includes test data for gas volume, gas composition, LFL, maximum burning velocity, and maximum closed vessel deflagration pressure.

G.8.4.4 Deflagration Venting and Application of NFPA 68 Considerations.

Explosion venting is purposeful discharge of pressures generated from combustion gases during a deflagration to maintain pressures below the enclosure damage threshold of a structure. The engineered discharge vent opening is typically achieved by one or more transient pressure-relieving panels, rupture discs, or other engineered vent devices. The most effective explosion venting systems are those that deploy early in the deflagration, have as large a vent area as possible, and allow unrestricted venting of combustion gases. Early vent deployment requires the vent be released at the lowest possible pressure without interfering with normal operations and pressure fluctuations in the enclosure. In the case of vents on exterior walls and roofs of buildings, the minimum feasible vent release pressure is usually slightly larger than the highest expected differential pressure associated with wind loads [typically 0.14 to 0.21 psig (0.96 to 1.44 kPa)].

Crucial aspects of vented-gas-explosion data correlations (obtained from the UL 9540A cell and module level test reports) are mixture reactivity, turbulence sources (both initial turbulence and obstacle-flame interaction turbulence velocities), vessel volume (i.e., scale) effects, and vessel geometry (primarily length/diameter ratio), as well as the vent parameters: vent area, vent release pressure, and vent panel inertia. All aspects of these parameters should be made available to both the fire protection engineer of record and the AHJ.

The amount of vent area needed for effective explosion venting depends on the size of the enclosure and the rate of pressure rise within it. According to Equation 6.1.1 of NFPA 68, the rate of pressure rise in an unvented enclosure is proportional to the product of the mixture effective burning velocity and flame surface area and varies inversely with the enclosure volume.

NFPA 68 provides the recognized guidance for the design, location, installation, maintenance, and use of devices and systems that vent combustion gases and pressures resulting from a deflagration within an enclosure. However, it is noted NFPA 68 does not apply to emergency vents for pressure generated during runaway exothermic reactions, self-decomposition reactions, internal vapor generation resulting from electrical faults, or pressure generation mechanisms other than deflagration.

The process for calculating the surface area for deflagration venting is presented in NFPA 68 and the parameters to accomplish this analysis include protection volume, enclosure strength, reaction forces to counteract vent dynamics, enclosure geometry, enclosure internal surface area, gas fuel properties, flame enhancement, panel inertia, and partial volume deflagration considerations. Determination of each of these inputs should be documented by the HMA.

Large-scale testing can be used to demonstrate the effectiveness of vent areas and design approaches. Large-scale testing can demonstrate resultant damage of vent areas reduced from those specified in Chapters 7 and 8 of NFPA 68. An AHJ can then assess that damage is acceptable for an installation location and type.

Comprehensive assessment of resultant hazards for placement of deflagration venting systems also include fireball size determination in addition to enclosure pressure rise and rupture risk.

G.8.4.5 Combustible Gas Reduction Systems and the Application of NFPA 69 Considerations.

The recognized national consensus standard to be used for the design and construction of explosion prevention systems is NFPA 69 and should be used in conjunction with Section G.8 to design combustible gas concentration reduction systems.

All components involved with the detection and ventilation of the combustible gas reduction system are considered part of a critical safety system and are subject to the normative requirements of state codes and applicable sections of NFPA 69.

For effective and efficient mitigation of explosions within energy storage systems, the intentional use of the container ventilation system as a safety barrier to limit or control flammability limits, the following measures can be considered:

(1) External ventilation at nominal rate in case of absence of carbon monoxide (to be measured by local CO detector).

(2) Increase of external ventilation rate to 400 Nm^3/h (or more) in case of combustible gas or CO detection in the container. The high CO content of the combustible gases generated during thermal runaway of batteries allows a rapid detection based on CO concentration.

(3) Independent auxiliary power supply to the external ventilation system (fan and louvers, to avoid common mode failures in case of fire in the container).

However, it is understood the ESS thermal management system for internal container environmental control does not directly control or impact cell thermal runaway of one or more degraded cells. In the event of such a fire, the intentional operation of the ESS ventilation system might increase the combustion of the combustible gases by the introduction of fresh air into the container. Conversely, the introduction of fresh air might assist in diluting the combustible gases from reaching the LFL. Therefore, as part of the engineering controls and analysis for mitigating an explosive environment, stakeholders and practitioners should consider adopting a well-evaluated risk-reduction and hazard mitigation strategy. This risk-reduction and hazard mitigation strategy should consider the appropriate variables and controls necessary to establish fire scenario metrics, energy storage management system performance permissives, and other administrative controls to determine the appropriate measures of when to stop/de-energize the ventilation in case of a confirmed container compartment fire.

Depending on the complexity of the ESS, it is recommended a steady-state numerical or computational fluid dynamics (CFD) analysis be performed whereby multivariable attribute analysis can be performed to assist in the engineering risk reduction decision process. Each methodology has the strengths and weaknesses that should be carefully considered when evaluating mitigative measures.

In all modeling and analysis methodologies used, it is recommended that NFPA 69 be relied upon for verification and validation by the fire protection engineer of record of conclusions and results. The most common use of NFPA 69 for ESS facilities is presented in Chapter 8. Chapter 8 outlines the requirements and techniques for maintaining the combustible gas concentration below the LFL.

Section 8.2.3.2 of NFPA 69 requires ESS facility owners or operators to provide complete documentation and a detailed description of the protection system to be used for monitoring and controlling combustible gas concentrations. This system usually includes the following components:

(1) Battery management system (BMS) provisions for detecting and controlling incipient cell anomalies that could lead to a thermal runaway.

(2) Gas detection provisions designed to sense concentrations of various thermal runaway combustible gases produced in the early stages of a runaway and send an alarm to the BMS and external system monitors.

(3) Normal and emergency ventilation and ESS enclosure exhaust components and provisions designed to dilute and expel combustible vapors, including the ventilation control, air handler, louvers, and so forth.

Section 8.2.3.4 of NFPA 69 requires the protection system design be reviewed by a qualified person acceptable to the facility's AHJ (typically, the fire protection engineer of record). Other paragraphs require the ESS owner or operator to provide maintenance of the system after installation and acceptance, and to arrange for periodic inspection by personnel trained by the protection system manufacturer(s).

There is one important commonly overlooked requirement in NFPA 69 applicable to an instrumented explosion prevention control system, also known as a safety instrumented system (SIS). To achieve a minimum documented level of system reliability, 15.5.5 of NFPA 69 requires an SIS (installed after November 5, 2021) to be either listed for explosion prevention service or evaluated to demonstrate a safety integrity level (SIL) 2 rating in accordance with ANSI/ISA 84.000.01 (or IEC 61511 and IEC 61508, or approved equivalent functional safety standards). Demonstrated compliance in the determination of SIL 2 is to be conducted by a certified functional safety professional. Therefore, the review of all ESS instrumented explosion prevention systems should include a careful assessment of component and system reliability.

Section 9.6.6.6 of this document and 8.3.1 of NFPA 69 the combustible gas concentration to be maintained at or below 25 percent of the LFL. This can be achieved by implementing the requirements of 9.6.6.6.7(1) of NFPA 855 where the combustible gas concentration reduction system detection is activated when combustible gas concentrations reach 10 percent LFL.

If the combustible gas concentration reduction system includes safety interlocks, there is a provision in 8.3.1 of NFPA 69 where systems are allowed to maintain combustible gas concentrations at or below 60 percent of the LFL. This is an important provision for BESS combustible gas reduction systems are shown to have reliable continuous monitoring of incipient thermal runaway combustible gases, though monitoring of thermal runaway gases might be challenged by the complexity of gas mixture and potential cross-sensitivity of measurement technologies.

Subsection 8.3.3 of NFPA 69 contains requirements for ventilation and air intake and exhausts. These requirements include locating air intakes and exhausts such that combustible gas discharged from one enclosure will not enter the air intake of an adjacent enclosure.

Annex D of NFPA 69 describes ventilation calculation methods to estimate the concentration of a combustible gas released into a ventilated enclosure, such as a BESS container. Equations are given for simple applications, including calculating the number of enclosure air changes per minute required to limit the average gas concentration to some fraction of the LFL. These equations are special case solutions to Equation G.8.4.5 for gas concentration, *C*, as a function of time, *t*:

$$G = V \; dC / dt + QC \qquad \textbf{[G.8.4.5]}$$

where:

V = enclosure volume

Q = enclosure ventilation rate

G = gas volumetric release rate

To account for ventilation mixing issues (i.e., nonuniform concentrations), the value of *Q* in Equation G.8.4.5 is replaced by *KQ*, where *K* is an empirically determined mixing efficiency factor for the specific ventilation arrangement.

Other factors to be considered in the design of the combustible gas reduction system are presented in Section 6.3 of NFPA 69 and include the reliability of this safety-critical system. Safety-critical reliability factors to be included in its design are presented in 6.3.1 of NFPA 69. Recent industry experience has demonstrated the importance of the purposeful evaluation of the possibility of electrical and mechanical malfunctions as part of the overall system reliability determination. ESSs that relies upon auxiliary power systems should evaluate probability of the mean time between failures (MTBF) of electrical supply for the energization and control of SIS critical safety systems within an ESS for project-specific emergency operating conditions for the duration of primary and potentially secondary thermal runaway events. Auxiliary or standby power systems designed in accordance with NFPA 110 should be at a minimum Type 10 and should provide auxiliary power to those critical safety systems for the anticipated duration of the fault condition.

Additional Proposed Changes

File Name	Description	Approved
Compare_for_Annex_G8.docx	Track Changes file for Annex Chapter G.8	

Statement of Problem and Substantiation for Public Comment

Explosion Studies and the requirements of Chapter 9.6.6.6 are complex. This file provides a finished product for guidance on explosion requirements - Updated by TG 4.

Related Item

- FR 109 • FR 196

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G.8

~~G.8 –~~ Explosion Hazard Analysis and Mitigation for Lithium Ion ESS

1. G.8.1 **Introduction**~~.~~
   1.1. ~~This section assists authorities having jurisdiction (AHJs),~~The motivation for the development of this annex is due to the ongoing challenges with the safe design of Lithium-ion energy storage systems where failures are resulting in thermal runaway events that release highly combustible concentrations of gases. When the combustible gases are ignited, the result is a complex combination of thermal and mechanical energy in the form of heat and pressure being released within an enclosure volume. In addition, depending on the concentration and the presence of an ignition source, these gases can cause enclosed areas to experience significant pressure transients which may result in the over pressurization of the ESS. Without an engineered solution to mitigate combustible gas accumulation or deflagration pressure rise,, overpressure can result in severe damage to the ESS and surrounding equipment or people.

   1.2. Therefore, this Annex is intended to aid AHJs, stakeholders, and practitioners with engineering design and risk mitigation considerations to minimize the likelihood and consequences of an explosion event~~.~~ through combustible concentration reduction. This section ~~does~~is not intended to prescribe how hazard and risk analyses are performed, rather ~~it presents~~to present principles and methodologies to ~~assist~~help the energy storage practitioner in the qualitative and quantitative analysis process~~.~~ of engineered solutions.

2. ~~G.8.2~~ **Essential Hazard Mitigation Analysis** ~~(HMA)~~ **Elements**~~.~~
   2.1. ~~G.8.2.1~~ Probability ~~and~~, Consequence~~.~~, and Mitigation

      2.1.1. In the design of these systems, ~~engineers~~Registered Engineering Professional must balance criteria for performance, cost, size, and safety concerns. ~~Achieving~~Outside of the risks and hazards of the technology being installed, consideration of the environment and location of where the project is located may require substantial additional mitigation measures. Recent industry experience where ESS have failed highlights the importance of achieving a high level of safety. This is ~~especially~~crucially important ~~in~~for applications in densely populated environments, such as indoor installations, where a thermal-runaway event is more likely to lead to harm to the occupants or may result in high losses of the structure and property.

      2.1.2. Conversely, there may be instances where the ESS project installation may be remote with no immediate threat to life, equipment, or the environment. Therefore, the Registered Engineering Professional must consider all aspects of the project, ESS technology, environmental considerations in the design development process of the engineered solution to mitigate the probability of the event occurrence and the measures to minimize the consequences.

      2.1.3. The first key feature of a hazard mitigation analysis is the identification and quantification of the explosive risks associated with the BESS design. Typically, explosion risk is quantified by assessing the probability of occurrence~~,~~ ~~consequences~~ of ~~the event, and detectability of the generation of flammable gases of an~~a thermal runaway (TR) event~~.~~ and the consequences of the event (deflagration, fire, arc flash, and electrical shock). Although the probability of an explosion is low in ~~compliant~~ listed and labeled ~~BESSs~~BESS, the effects and consequences can be ~~extremely~~ high. ~~The first key feature of an HMA is the identification and quantification of the explosive risks associated with the BESS design.~~

2.1.4. ~~Explosions~~Numerous scholarly research articles are available to assist the Registered Engineering Professional in calculating the probability of occurrence of TR for all events and estimation of the probability of severity of the event. However, the calculation of the probability of the TR event must consider the chemistry, cell and module design and include the engineering controls used to mitigate the TR from occurring. Typical reliability analyses tools such as Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis (FTA), and Weibull Analysis could be used to calculate the probability estimation of a TR event.

2.1.5. Determining the consequence of a TR event is a complex process requiring an understanding that explosions can occur wherever ~~flammable~~combustible gas is able to accumulate within its flammability limits in an enclosure. For an ESS, this ~~could~~may occur within a single rack enclosure, standalone enclosure, installation structure, or building. For more input on design scenarios and the numerical analysis methodologies, see Section 3.1.

~~Each lithium-ion battery chemistry presents unique explosive risks due to the complex nature of their failure mechanisms: they produce large volumes of flammable gases and produce sufficient oxygen to sustain exothermic reactions that can emit particles hot enough to ignite gases.~~

2.1.6. ~~A~~Lastly, as required with (ref section for the development of an HMA) a comprehensive Hazard Mitigation Analysis (HMA) should include an assessment of explosive risks of the ESS unit as well as the overall installation with site~~-~~ specific considerations of exposures, property safety, and life safety.

~~Each HMA should consider the integrated benefits of the purposeful layering of complementary engineering and administrative controls hierarchy thereby building defense in depth controls to establish a mitigated consequence probability.~~

2.2. ~~G.8.2.2~~ Hierarchy of Controls~~.~~

2.2.1. With ~~each identified~~ the hazard quantified, ~~the~~ mitigation objectives and associated approaches can then be considered based on acceptable risk ~~tolerance~~, feasibility, and the hierarchy of controls. Prevention of a TR event from occurring is always the highest control for the safe operation of an ESS. However, when that fails additional controls are necessary to reduce the potential of explosion in the operating environment.

Within the hierarchy of controls, explosion hazards can be managed by ~~engineering controls and administrative controls.~~

2.2.2. ~~Engineering controls should focus on reducing or eliminating~~reducing the generation of combustible gas, reducing the accumulation or concentration of combustible gas, and managing consequences of a deflagration with structural design and appropriate siting to exposures~~, and administrative controls.~~. Some available explosion risk mitigation strategies include ~~flammable~~combustible gas detection and exhaust, deflagration venting, inerting, suppression, hardening, and increased standoff distance to personnel and assets.

~~Administrative controls might include the proceduralization of operator instructions enabling early detection and purposeful deenergization of systems exhibiting degraded performance, increasing the breadth and depth of the scheduling of routine periodic maintenance focusing on safety critical system performance, implementation of daily operator status of health checks, or~~

~~any other purposeful operator interaction with the systems to increase visibility and early detection of abnormal system performance.~~

~~G.8.3 Engineering Controls Considerations.~~

~~G.8.3.1 Reducing the Probability of Combustible Gas Generation.~~

~~Detection and preventing the generation of combustible gas within BESSs should be the objective of all engineered energy storage systems.~~

~~The careful selection of the lithium-ion battery chemistry should be researched, considering cell failure propensity where the generation of combustible gas might require additional and costly mitigation measures.~~

~~Reliance on industry certifications for safe operations of OEM battery management systems (BMS) and thermal management systems has proven to not prevent thermal runaway events. Additional design considerations of the ESMS or critical safety control systems should include the ability to monitor state-of-health and performance of individual cells (e.g., voltage, current, temperature) and take compensatory measures to reduce overcharge, overdischarge, and overtemperature conditions resulting in the removal of the affected module or rack from service. Once deenergized, additional administrative controls can be implemented and can include any verification measure, including corrective maintenance and removal from service.~~

~~G.8.3.2 Preventing or Reducing the Probability of Combustible Gas Accumulation.~~

2.2.3. ~~The explosion potential can be eliminated or~~The second order of control is the minimization of generated combustible concentrations. The explosion potential can be reduced by preventing the accumulation of combustible gas within the installation or product enclosure. This control approach may be incorporated into the ESS design by limiting cell-to-cell thermal runaway propagation where the volume of combustible gases is minimized. Though outside the scope of an explosion protection design, ESS design may limit cell-to-cell thermal runaway propagation with passive barriers or active suppression approaches.

2.2.4. ~~To reduce flammable gas~~The third order of control is the reduction of accumulation ~~at the~~ within a given installation airspace. To reduce combustible gas accumulation in the installation airspace, a well-designed ~~combustible gas reduction (i.e.,~~ ventilation~~)~~ system must be incorporated. Design trends within the energy storage market sector include several different ~~and competing design~~ philosophies. ~~These designs range from~~One design approach involves containing the battery modules and off-gas in gas-tight enclosures leading directly to a safe area, without passing the battery room. Other engineered design approaches include opening battery rack enclosures to the battery compartment where ~~off-gas~~vented combustible concentrations can be readily diffused by a forced exhaust system of sufficient air changes per ~~hours~~hour (ACH~~).~~) where in bounding TR events, the combustible concentration limit will not exceed 25% of the lower flammability limit (LFL). Forced exhaust systems are typically designed in accordance with the appropriate American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and NFPA 69~~. Opening the access doors to the enclosure and flooding the container with environment thereby exposing~~ Standards. Exposing the battery compartment directly to the external environment is another method to meet the NFPA 855 explosion prevention and deflagration venting requirements.

~~G.8.3.3 Managing the Consequences of Deflagrations or Explosions.~~

~~A comprehensive ESS explosion hazard mitigation includes the purposeful management of the consequences of deflagration or explosion through the implementation of deflagration protection (NFPA 68) or explosion prevention (NFPA 69).~~

Each BESS equipment provider ~~should~~and Registered Engineering Professional must conduct an explosion hazard analysis to quantify the risks ~~(e.g., explosive pressures, direction, missile generation and projection, heat flux, fireball, and so forth) and~~and hazards ~~(e.g., personnel, equipment, and environmental safety) and~~as well as validate ~~proposed~~ mitigation designs~~. The proposed mitigative designs should objectively demonstrate conservative and bounding scenarios where the engineering controls mitigate the hazards. These mitigation analyses can be~~ in ~~the form of maximum theoretical steady-state analysis or computations fluid dynamics (CFD) modeling.~~

2.2.5. accordance with NFPA 69 and/or NFPA 68. When reviewing the computational fluid dynamics or other analyses performed, the ~~designer, functional safety engineer, practitioner, and~~ AHJ should consider other important elements ~~are~~ presented in the explosion hazard analysis, as applicable to the engineering analysis performed: enclosure reaction force; enclosure geometry; enclosure internal surface area including partial volumes; surface area of internal structures; ~~and flammable~~combustible gas properties~~,~~ including lower flammability limit (LFL), laminar flame speed, and maximum closed vessel deflagration pressure.

3. ~~G.8.4~~ Engineering ~~Controls and~~ Practices ~~for Explosion Hazard Mitigation.~~to Mitigate Hazards

3.1. ~~G.8.4.1~~ Design ~~Considerations.~~Failure Scenarios

3.1.1. ~~The broad range of recent global energy storage market sector failures and fires require the functional safety engineer to consider multiple~~The primary objective of the development of design failure scenarios is to establish the technically plausible, but bounding explosion events. The bounding failure events then can be used to establish specific and actionable performance targets of each scenario that an engineered system is designed to mitigate.

3.1.2. Multiple credible ~~and probabilistic~~ scenarios ~~as part of~~should be evaluated during the ~~HMA. Probabilistic~~explosion or deflagration hazard study. All plausible failure scenarios should include the ~~relevant data generated in the~~ UL 9540A cell and module ~~test as~~data as inputs to developing a ~~realistic option for failure resulting in fire or explosions. Analysis~~ plausible failure. All bounding plausible scenarios should also ~~include common-cause or common mode failures that also include plausible scenarios where ignition sources might be evident.~~take into account the appropriate initiating events (electrical abuse, mechanical abuse (drop, vibration, shock), thermal abuse and, arc flash on a module). Conservatism should always be applied to ensure a safety margin.

~~G.8.4.1.1~~

3.1.3. Recommended failure scenarios to consider in an HMA ~~include the following~~should consider:

3.1.3.1. Single cell failure vented combustible concentration constituents leading to a partial volume deflagration of a stoichiometric mixture at a local location.

~~1.~~3.1.3.2. UL 9540A test failure data and level: ~~One~~where thermal runaway propagation of one or more cells, ~~modules~~module, or units ~~based on~~ was observed and the heat and combustible concentration are recorded within the test results. Note: UL 9540A is designed to induce cell-to-cell propagation of thermal runaway and measure the resultant fire and explosion hazards.

~~2.~~3.1.3.3. Limited propagation failure~~: Adds~~ scenario. The objective of establishing a limited/bounding propagation scenario is add conservatism and safety margin to the UL 9540A test result. The UL 9540A test does not establish "if" the cells/module fail rather, it documents one way "how" the cell/module fail. The UL 9540A test results should never be considered as the only way how the cells fail as it is a thermal abuse test. Therefore, conservatism should always be added when establishing limited propagation failure scenarios. For example, if one cell failed with no propagation, then evaluate a ~~three~~3-cell failure~~—~~, one on either side. ~~If~~ Similarly, if the UL 9540A test demonstrates a module failed under test but did not propagate, then limited propagation scenario should evaluate ~~a three~~ 3 module failure~~—~~ (one above and below) within a given unit.

~~3.~~3.1.3.4. ~~*Twenty-five percent*~~25% LFL failure: ~~Determine how may cells it takes~~Using the UL 9540A Cell and Module data, determine the number of cells failures required to generate a combustible concentration to reach 25 ~~percent~~% LFL in the enclosure airspace. This ~~might~~may overlap with another design scenario.

~~4.~~3.1.3.5. Partial volume deflagration: ~~Determine how many cells can fail with a resulting~~Recognizing the highest levels of combustible concentration of vented gases will be closer to the source, the Registered Engineering Professional should determine the number of cells failures to generate a partial volume deflagration that does not produce a pressure ~~value that will cause~~transient causing the enclosure to fail.

3.1.3.6. Worst total failure~~: Assume all cells in~~ (Stoichiometric) – assumes within the bounding analysis, the largest number of cells fail creating a maximum stoichiometric mixture.

~~5.~~ In addition to establishing the ESS ~~fail.~~

~~G.8.4.2 Combustible Gas Venting Pathway.~~

~~If~~failure scenario, it is also incumbent to recognize that if the lithium battery releases gas under pressure and velocity, there are a number of determining factors that influence the release rates and ~~initial geometry~~dispersion of the escaping gases. The pressurized gas is released as a gas jet and~~,~~ depending on the nature of the failure, ~~might~~may be directed by the module cooling ~~system~~systems exhaust pathway. Escaping gases are normally very turbulent and air will immediately be drawn into the mixture. The mixing of air will also reduce the velocity of the escaping gas jet. Obstacles such as the module racking system, cable trays, conduit, HVAC ducting, buswork, structures, ~~and so forth,~~etc., will disrupt momentum forces of any pressurized release~~ thereby adversely impacting turbulent burning velocities.~~

~~BESS designs that include obstructions (e.g., conduit and piping arrays, internal obstructions) within the combustible gas venting pathway can have a significant impact on flame speed and enclosure pressures due to the turbulence generated during the flow of unburned gas over and around the obstacles. In the likely event of igniting of the combustible gas, the flame front surface area is increased as a function of the obstacle surface area resulting in increased pressure transients.~~

3.1.4. ~~If the release of combustible gas is~~. These releases, if not detected and/or ignited~~,~~ ~~the gas~~ will then generally form a vapor cloud that ~~will be distributed throughout the BESS enclosure through mechanical ventilation or~~ would naturally ~~disperse~~or mechanically be dispersed in the atmosphere. ~~Once the combustible gas reaches the flammability limits and is exposed to~~ If the gases do not escape the enclosure airspace they will likely be ignited, resulting in an ~~ignition source, an explosive blast~~

~~will occur. The resultant~~explosion if the cloud is in a relatively confined area. Where turbulent dispersion processes ~~will be~~are prevalent (e.g., high pressure flow, winds, congestion, ~~and so forth),~~etc.) the gas will spread in both horizontal and vertical dimensions while continually mixing with available oxygen in the air. Initially, ~~escaping~~vented gases from a cell or module are above the UEL, but with dispersion and turbulence effects, they will rapidly pass into the ~~flammable~~combustible range. ~~If not ignited and given an adequate distance for dilution by the environment, they will eventually disperse below the LEL.~~ Various computer software programs are currently available that can calculate the turbulent gaseous jet dispersion, downwind explosive atmospheric locations, and volumes for any given combustible commodity, release rates, and atmospheric ~~date~~and environmental conditions of the analyzed scenario input (i.e., wind direction and speed).

~~G.8.4.3 Combustible Gas Reduction System.~~

3.1.5. Depending on the Hierarchy of Controls applied, industry experience has demonstrated the most commonly applied control is the explosion prevention through combustible concentration reduction. To design a combustible ~~gas~~concentration reduction system, the properties of the combustible gas must be known or assumed and validated. The major components of a lithium-ion battery gas thermal runaway are typically hydrogen, carbon monoxide, carbon dioxide, and various hydrocarbons. While lithium-ion battery failures ~~can~~may result in differing gas compositions based on state of charge (SOC), gas release quantity is higher and flammability properties are more severe as SOC increases. Battery thermal runaway gas composition is characterized experimentally for 100~~ percent~~% SOC under the cell~~-~~ level test method of UL 9540A. This characterization includes test data for gas volume, gas composition, ~~LFL~~lower flammability limit, maximum burning velocity, and maximum closed vessel deflagration pressure. Combustible Concentration Reduction Systems design considerations is presented in 3.2

~~G.8.4.4 Deflagration Venting and Application of NFPA 68 Considerations.~~

~~Explosion venting is purposeful discharge of pressures generated from combustion gases during a deflagration to maintain pressures below the enclosure damage threshold of a structure. The engineered discharge vent opening is typically achieved by one or more transient pressure-relieving panels, rupture discs, or other engineered vent devices. The most effective explosion venting systems are those that deploy early in the deflagration, have as large a vent area as possible, and allow unrestricted venting of combustion gases. Early vent deployment requires the vent be released at the lowest possible pressure without interfering with normal operations and pressure fluctuations in the enclosure. In the case of vents on exterior walls and roofs of buildings, the minimum feasible vent release pressure is usually slightly larger than the highest expected differential pressure associated with wind loads [typically 0.14 to 0.21 psig (0.96 to 1.44 kPa)].~~

~~Crucial aspects of vented-gas-explosion data correlations (obtained from the UL 9540A cell and module level test reports) are mixture reactivity, turbulence sources (both initial turbulence and obstacle-flame interaction turbulence velocities), vessel volume (i.e., scale) effects, and vessel geometry (primarily length/diameter ratio), as well as the vent parameters: vent area, vent release pressure, and vent panel inertia. All aspects of these parameters should be made available to both the fire protection engineer of record and the AHJ.~~

~~The amount of vent area needed for effective explosion venting depends on the size of the enclosure and the rate of pressure rise within it. According to Equation 6.1.1 of NFPA 68, the~~

~~rate of pressure rise in an unvented enclosure is proportional to the product of the mixture effective burning velocity and flame surface area and varies inversely with the enclosure volume. NFPA 68 provides the recognized guidance for the design, location, installation, maintenance, and use of devices and systems that vent combustion gases and pressures resulting from a deflagration within an enclosure. However, it is noted NFPA 68 does not apply to emergency vents for pressure generated during runaway exothermic reactions, self-decomposition reactions, internal vapor generation resulting from electrical faults, or pressure generation mechanisms other than deflagration.~~

~~The process for calculating the surface area for deflagration venting is presented in NFPA 68 and the parameters to accomplish this analysis include protection volume, enclosure strength, reaction forces to counteract vent dynamics, enclosure geometry, enclosure internal surface area, gas fuel properties, flame enhancement, panel inertia, and partial volume deflagration considerations. Determination of each of these inputs should be documented by the HMA.~~

~~Large-scale testing can be used to demonstrate the effectiveness of vent areas and design approaches. Large-scale testing can demonstrate resultant damage of vent areas reduced from those specified in Chapters 7 and 8 of NFPA 68. An AHJ can then assess that damage is acceptable for an installation location and type.~~

~~Comprehensive assessment of resultant hazards for placement of deflagration venting systems also include fireball size determination in addition to enclosure pressure rise and rupture risk.~~

3.2. ~~G.8.4.5~~ Combustible ~~Gas~~Concentration Reduction Systems and the Application of NFPA 69 ~~Considerations.~~to ESS

3.2.1. The recognized national consensus standard to be used for the design and construction of explosion prevention systems is NFPA 69:2019 and should be used in conjunction with ~~Section G.8~~this guidance to design combustible~~ gas~~ concentration reduction systems.

~~All components involved with the detection and ventilation of the combustible gas reduction system are considered part of a critical safety system and are subject to the normative requirements of state codes and applicable sections of NFPA 69.~~

3.2.2. For effective and efficient mitigation of explosions within energy storage systems, the intentional use of the container ventilation system as a safety barrier to limit or control flammability limits, the following measures can be considered:

~~1.~~3.2.2.1. External ventilation at nominal rate in case of absence of carbon monoxide (to be measured by local CO detector).

3.2.2.2. The external ventilation system should conservatively apply the portions of the fan performance curves with a realistic static pressure. Certain jurisdictions require field verification of this critical safety system performance and industry experience has demonstrated typical maximum flow with zero static pressure cannot be achieved through empirical field testing.

3.2.2.3. Time lags and response times of the combustible concentration detection system (detectors, fan motors, louvers, and logic solvers) must also be considered. Depending on the components selected, combustible concentration detectors response time ranges from 10s of seconds to minutes. The same challenge also exists for the response time of the fan motors and louvers. It is recommended that the combination of response times be considered against the maximum combustible gas generation rates within the design development process.

~~2.~~3.2.3. Increase of external ventilation rate ~~to 400 Nm^3/h (or more) in case of combustible gas~~ following H2 and/ or CO detection in the container. The high CO content of the combustible ~~gases~~concentration generated during thermal runaway of batteries allows ~~a~~ rapid detection based on CO concentration.

~~3.~~3.2.4. ~~Independent auxiliary~~Fire codes and Authority Having Jurisdiction require an independent power supply, and in some cases the power supply is backed by an approved NFPA 110 or NFPA 111 emergency power supply system (EPSS) to the external ventilation system (~~fan and louvers,~~ to avoid common mode failures in case of fire in the container).

3.2.5. However, it is understood the ESS ~~thermal management system~~Thermal Management System for internal container environmental control does not directly control or impact cell thermal runaway of one or more degraded cells. In the event of such a fire, the intentional operation of the ESS ventilation system ~~might~~may increase the combustion of the combustible gases by the introduction of fresh air into the container. Conversely, the introduction of fresh air ~~might~~may assist in diluting the combustible ~~gases~~concentration from reaching the lower flammability limit (LFL~~.~~). Therefore, as part of the engineering controls~~ and analysis~~ for mitigating an explosive environment, stakeholders and practitioners should consider adopting a well~~-~~ evaluated risk-reduction and hazard mitigation strategy. This risk-reduction and hazard mitigation strategy should consider the appropriate variables and controls necessary to establish fire scenario metrics, energy storage management system performance permissives, and other administrative controls to determine the appropriate measures of when to stop/de-energize the ventilation in case of a confirmed container compartment fire.

3.2.6. Depending on the complexity of the ESS~~,~~ it is recommended a ~~steady-state numerical or~~three-dimensional (3D) computational fluid dynamics (CFD) analysis be performed whereby multivariable attribute analysis can be performed to assist in the engineering risk reduction decision process. ~~Each methodology has the strengths and weaknesses that should be carefully considered when evaluating mitigative measures.~~

3.2.7. ~~In~~The influence of external ventilation on the combustible cloud volume in a battery container upon thermal runaway of Li-Ion batteries was investigated in this Annex. For a single battery module thermal runaway, preliminary results from CFD simulations demonstrate the effect that increased ventilation rates can have on the combustible cloud size. Figure 1 shows how increasing the ventilation rate from 5 to 10 air changes per hour (ACH) reduces the maximum combustible cloud size by more than 20%. For complete failure of a single battery rack containing 15-20 modules, CFD dispersion simulations show that propagating thermal runaway may result in a 50% volume filling of an equivalent stoichiometric gas cloud. This gas cloud contains gradients of gas concentrations and air. If the gas discharge rate is high enough (relative to external ventilation), the atmosphere inside the container will become saturated, reducing the size of the combustible cloud. If ventilation is increased, then the combustible cloud size increases with increasing ventilation rates. This is why ventilation is mainly useful when the thermal runaway can be limited to one of just a few battery modules.

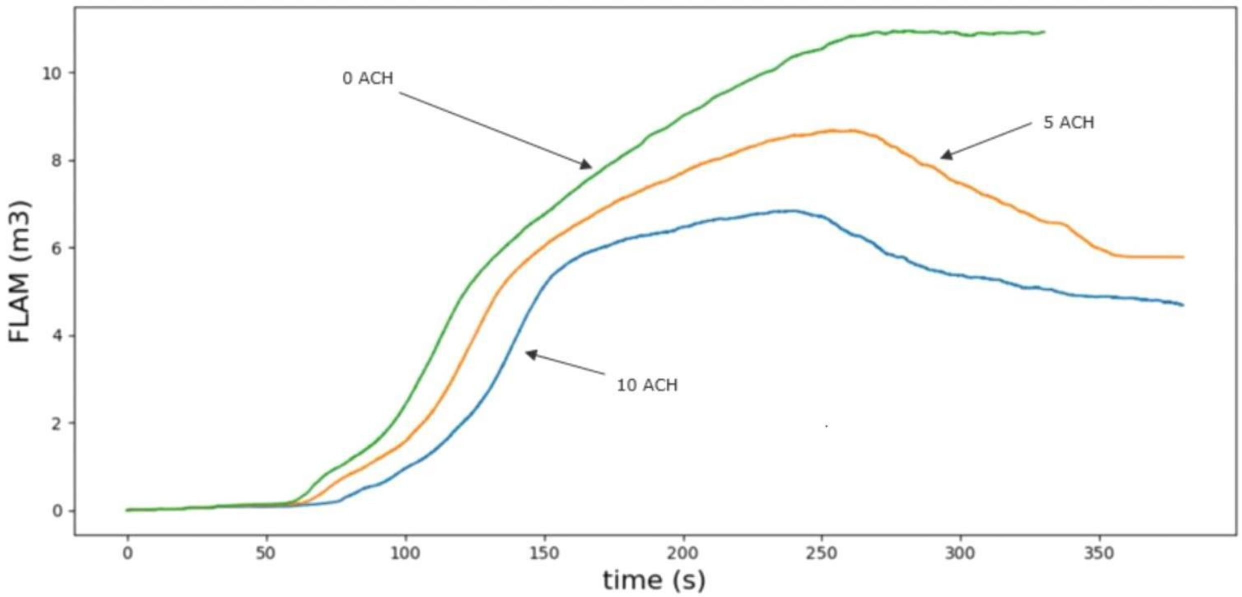

Figure 1: Reduction of flammable cloud size in a battery room for varying ventilation rates (Warner et al, 2018)

3.2.8. CFD simulations indicate explosion involving a whole container filled with the stoichiometric battery gas mixture will result in overpressures superseding the design threshold of the container. Assuming overpressure on the container walls, one can determine the relief panel area and weight required to reduce the overpressure below the design threshold of the container. The explosion pressures are found by modeling the same explosion event several times with varying panel weight and size.

3.2.9. As stated, in all modeling and analysis methodologies used, it is recommended that NFPA 69:2019 be relied upon for verification and validation ~~by the fire protection engineer of record of~~ of conclusions and results. The most common use of NFPA 69 for ESS facilities is presented in Chapter 8~~.~~, Deflagration Prevention by Combustible Concentration Reduction. Chapter 8 outlines the requirements and techniques for maintaining the combustible gas concentration below the ~~LFL.~~Lower Combustible Limit (LFL).

3.2.10. ~~Section~~NFPA 69 paragraph 8.2.3.2 ~~of NFPA 69~~ requires ESS facility ~~owners~~owner or ~~operators~~operator to provide complete documentation and a detailed description of the protection system to be used for monitoring and controlling combustible gas concentrations. This system usually includes the following components:

~~1.~~3.2.10.1. Battery management system (BMS) provisions for detecting and controlling incipient cell anomalies that could lead to a thermal runaway.

~~2.~~3.2.10.2. Gas detection provisions designed to sense concentrations of various thermal runaway combustible gases produced in the early stages of a runaway and send an alarm to the BMS and external system monitors.

~~3.~~3.2.10.3. Normal and emergency ventilation and ESS enclosure exhaust ~~components and~~ provisions designed to dilute and expel combustible vapors~~, including the ventilation control, air handler, louvers, and so forth~~.

~~Section~~NFPA 69 paragraph 8.2.3.4~~ of NFPA 69~~ requires the protection system design be reviewed by a qualified person acceptable to the facility's ~~AHJ (typically, the fire protection engineer of record).~~authority having jurisdiction. Other paragraphs require the ESS owner or operator to provide maintenance of the system after installation and acceptance, and to arrange for periodic inspection by personnel trained by the protection system manufacturer(s).

3.2.11. There is one important ~~commonly overlooked requirement~~new provision in NFPA 69 applicable to an instrumented explosion prevention control system, also known as a safety instrumented system (SIS). ~~To~~ In order to achieve a minimum documented level of system reliability, section 15.5.5 ~~of NFPA 69~~ requires an SIS ~~(~~installed after November 5, 2021~~)~~ to be either listed for explosion prevention service or evaluated to demonstrate a safety integrity level ~~(SIL)~~ 2 rating in accordance with ANSI/ISA 84.000.01~~ (or IEC 61511 and IEC 61508, or approved equivalent functional safety standards). Demonstrated compliance in the determination of SIL 2 is to be conducted by a certified functional safety professional~~. Therefore, the review of all ESS instrumented explosion prevention systems should include a careful assessment of component and system reliability.

~~Section 9.6.6.6 of this document and~~ NFPA 69 paragraph 8.3.1 ~~of NFPA 69~~requires the combustible gas concentration to be maintained at or below 25 percent of the LFL. ~~This can be achieved by implementing the requirements of 9.6.6.6.7(1) of NFPA 855 where the~~ There is an exception for installations that have continuous monitoring of combustible gas concentration ~~reduction system detection is activated when~~and associated safety interlocks to control combustible gas concentrations~~ reach 10 percent LFL.~~

3.2.12. ~~If the combustible gas concentration reduction system includes safety interlocks, there is a provision in 8.3.1 of NFPA 69 where~~. Such explosion prevention systems are allowed to maintain combustible gas concentrations at or below 60 percent of the LFL. This is an important provision for BESS ~~combustible gas reduction~~explosion prevention systems ~~are~~that can be shown to have reliable continuous monitoring of incipient thermal runaway combustible gases, though monitoring of thermal runaway gases ~~might~~may be challenged by the complexity of gas mixture and potential cross-sensitivity of measurement technologies.

3.2.13. ~~Subsection 8.3.3 of~~ NFPA 69 section 8.3.3 contains requirements for ventilation and air ~~intake~~intakes and exhausts. These requirements include locating air intakes and exhausts such that combustible gas discharged from one enclosure will not enter the air intake of an adjacent enclosure.

3.2.14. NFPA 69 Annex D~~ of NFPA 69~~ describes ventilation calculation methods to estimate the concentration of a combustible gas released into a ventilated enclosure~~,~~ such as a BESS container. Equations are given for simple applications~~,~~ including calculating the number of enclosure air changes per minute required to limit the average gas concentration to some fraction of the LFL. These equations are special case solutions to ~~Equation G.8.4.5~~the following equation for gas concentration, C, as a function of time, t:

~~**[G.8.4.5]**~~

~~where:~~

~~V = enclosure volume~~

~~Q = enclosure ventilation rate~~

~~G = gas volumetric release rate~~

$$V\,dC/dt + QC = G \quad (Eqn.1)$$

where: V is the enclosure volume, Q is the enclosure ventilation rate, and G is the gas volumetric release rate.

To account for ventilation mixing issues ~~(~~, i.e~~., nonuniform~~. non-uniform concentrations~~)~~, the value of Q in Equation ~~G.8.4.5~~1 is replaced by KQ, where K is an empirically determined mixing efficiency factor for the specific ventilation arrangement. The solution of Eqn 1 for the case of constant gas release rate starting at t=0, is

~~Other factors to be considered in the design of the combustible gas reduction system are presented in Section 6.3 of NFPA 69 and include the reliability of this safety-critical system. Safety-critical reliability factors to be included in its design are presented in 6.3.1 of NFPA 69. Recent industry experience has demonstrated the importance of the purposeful evaluation of the possibility of electrical and mechanical malfunctions as part of the overall system reliability determination. ESSs that relies upon auxiliary power systems should evaluate probability of the mean time between failures (MTBF) of electrical supply for the energization and control of SIS critical safety systems within an ESS for project-specific emergency operating conditions for the duration of primary and potentially secondary thermal runaway events. Auxiliary or standby power systems designed in accordance with NFPA 110 should be at a minimum Type 10 and should provide auxiliary power to those critical safety systems for the anticipated duration of the fault condition.~~

$$C = \frac{G}{Q}\left(1 - e^{\frac{KQt}{V}}\right) \text{ (Eqn.2)}$$

required number of air changes for dilution, N, resulting in a given concentration. is introduced implicitly as being equal to $N = {}^{Qt}/_{V}$. Figure D.3b is a graph showing C calculated from Eqn 2, and Figure D.3a shows the solution for dilution after the release rate is terminated.

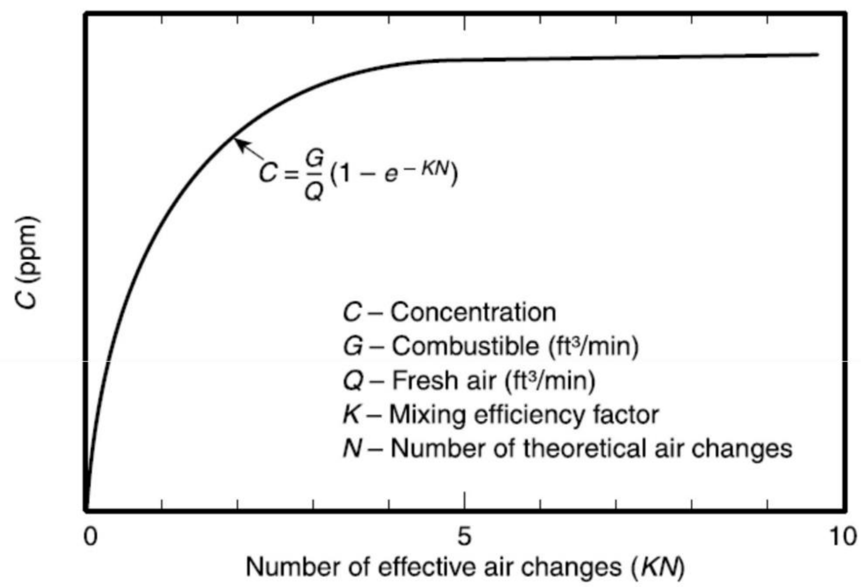

FIGURE D.3(b) Combustible Buildup Curve. General Ventilation: Continuous Release.

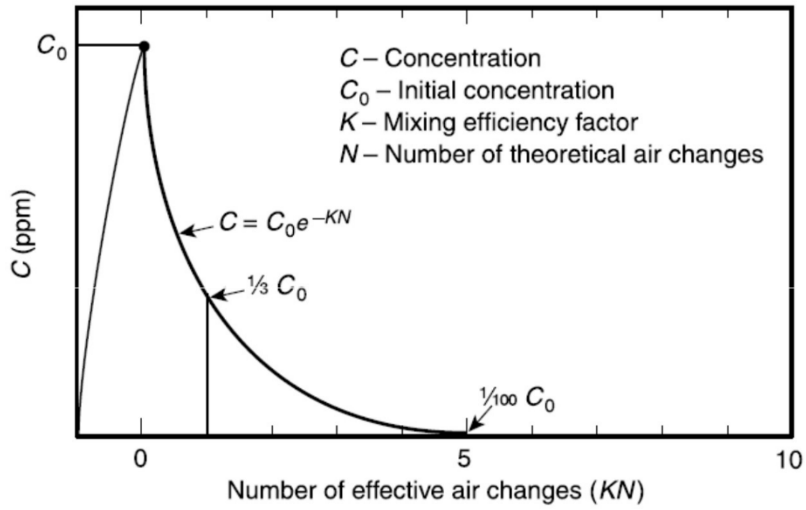

FIGURE D.3(a) Combustible Decay Curve. General Ventilation: Instantaneous Release.

4. Assumptions and Limitations to be considered while using this guidance

4.1. Assumptions

The mechanical exhaust system is generally conceptually designed based on the assumptions listed by the engineers. If these assumptions change, additional analysis would need to be performed. Some of the assumptions are listed below but not limited to:

- Installed detector characteristics (location, detection threshold, and response time) are the same as those used by the design engineer,
- No fire or explosion is assumed for NFPA 69 analysis
- The analysis generally does not consider the activation of a clean agent or an aerosol-based suppression system that may impact the performance of the detection system and the ventilation system.

4.2. Limitations

- The performance of the emergency ventilation system analysis is based on maintaining the global-averaged battery gas concentration to values below 25% of its LFL. However, this system cannot prevent the local accumulation of battery gas, resulting in a gas concentration exceeding the 25% LFL limit locally, especially near the module in thermal runaway. A partial volume deflagration analysis can be performed to quantify the residual hazard.
- The ventilation system reduces the risk of an explosion but does not eliminate an explosion risk, as is evident by the potential for local flammable gas mixtures to be formed in the enclosure and the ability of a battery failure with jetting gases to be a capable ignition source.
- The selected parameters used during this type of analysis are generally based on the information provided by the customer. Specifically, the UL 9540A test reports are used as the basis of this hazard assessment.

Public Comment No. 352-NFPA 855-2024 [Section No. H.1.2]

H.1.2 Other Publications.

H.1.2.1 CENELEC Publications.

CENELEC, European Committee for Electrotechnical Standardization, CEN-CENELEC Management Centre, Rue de la Science 23, B - 1040 Brussels, Belgium.

EN 15276-1, *Fixed firefighting systems — Condensed aerosol extinguishing systems — Part 1: Requirements and test methods for components*, 2019.

EN 15276-2, *Fixed firefighting systems — Condensed aerosol extinguishing systems — Part 2: Design, installation and maintenance*, 2019.

EN 60079-29-1, *Gas detectors — Performance requirements of detectors for flammable gases, Amendment 1 — Explosive atmospheres*, 2016, amended 2020.

H.1.2.2 CSA Group Publications.

CSA Group, 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada.

CAN/CSA C22.2 No. 107.1, Power conversion equipment, 2016, reaffirmed 2021.

CAN/CSA C22.2 No. 62109-1, *Safety of power converters for use in photovoltaic power systems — Part 1: General requirements*, 2016, reaffirmed 2021.

CSA C22.2 No. 62368-1, *Audio/video, information and communication technology equipment — Part 1: Safety requirements*, 2014, revised 2019.

H.1.2. 3 FM Global Publications.

FM Global, 1175 Boston-Providence Turnpike, PO Box 9102, Norwood, MA 02062.

FM 6320, *Approval Standard for Combustible Gas Detectors* , 2018.

FM 6325, *Open Path Detectors for Flammable Gases* , 2019.

FM 6340, *Examination Standard for Toxic Gas and Oxygen Depletion Detectors* , 2022.

H.1.2. 3 FPRF Publications.

Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02169-7471.

Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results, July 2013.

H.1.2.4 IAS Publications.

International Accreditation Service (IAS), 3060 Saturn Street, Suite 100, Brea, California 92821.

AC354, *Accreditation Criteria For Field Evaluation Of Unlisted Electrical Equipment*, December 2021.

H.1.2.5 ICC Publications.

International Code Council, 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001.

Uniform Fire Code, 1997.

H.1.2.6 IEC Publications.

International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 60812, *Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA*), 2006.

IEC 61025, *Fault tree analysis (FTA)*, 2006.

IEC 61508-SER, *Electronic Functional Safety Systems Package —– All Parts*, 2010.

IEC 61511-SER, *Functional safety — Safety instrumented systems for the process industry sector — All Parts*, 2016, revised 2017.

H.1.2.7 IEEE Publications.

IEEE, 3 Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, 2010.

IEEE 484, *IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*, 2019.

IEEE 1187, *Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications*, 2013.

IEEE 1188, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 2005.

IEEE 1547, *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, 2018.

IEEE 1635/ASHRAE 21, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications,* 2018.

IEEE 3007.1, *Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems*, 2010.

IEEE C2, *National Electrical Safety Code*, 2017.

H.1.2.8 ISA Publications.

International Society of Automation, 67 T.W. Alexander Drive, Research Triangle Park, NC 27709.

ISA TR84.00.07, *Guidance on the Evaluation of Fire and Gas System Effectiveness*, 2010, revised 2018.

ANSI/ISA 84.00.01, *Functional Safety: Safety Instrumented Systems for the Process Industry Sector — Part 1: Framework, Definitions, System, Hardware and Software Requirements*, 2004.

H.1.2.9 ISO Publications.

International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland.

ISO 9001, *Quality management systems — Requirements*, 2015.

ISO 12944, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems*, 2018.

H.1.2.10 Military Specifications.

Department of Defense Single Stock Point, Document Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-1629A, *Procedures for Performing a Failure Mode, Effects and Criticality Analysis,* 1980.

H.1.2.11 NECA Publications.

National Electrical Contractors Association, 3 Bethesda Metro Center, Suite 1100, Bethesda, MD 20814.

NECA 416, *Recommended Practice for Installing Energy Storage Systems (ESS)*, 2017.

H.1.2.12 SFPE Publications.

Society of Fire Protection Engineers, 9711 Washingtonian Blvd., Suite 380, Gaithersburg, MD 20878.

SFPE Engineering Guide to Fire Risk Assessment, 2006.

SFPE Handbook of Fire Protection Engineering, 2016.

H.1.2.13 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 268, *Smoke Detectors for Fire Alarm Systems*, 2016, revised 2023.

UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021.

UL 1642, *Lithium Batteries*, 2020, revised 2022.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2023.

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CAN/UL 1973, *Batteries for Use in Stationary and Motive Auxiliary Power Applications,* 2022.

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UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019.

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2014, revised 2019.

CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

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

H.1.2.14 UN Publications.

United Nations Headquarters, 760 United Nations Plaza, New York, NY 10017.

UN 38.3, *Recommendations on the Transport of Dangerous Goods: Lithium Metal and Lithium Ion Batteries*, 2015.

UN 2800, *Batteries, wet, non-spillable, electric storage*, 2017.

H.1.2.15 US Government Publications.

US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 29, Code of Federal Regulations, Part 1910.38, “Emergency Action Plans.”

Title 29, Code of Federal Regulations, Part 1910.39 “Fire Prevention Plans.”

Title 29, Code of Federal Regulations, Part 1910.120(q)(6), “Hazardous Waste Operations and Emergency Response—Emergency Response to Hazardous Substance Releases—Training.”

Title 29, Code of Federal Regulations, Part 1910.147, “The Control of Hazardous Energy (Lockout/Tagout).”

Title 29, Code of Federal Regulations, Part 1910.269(d), “Electric Power Generation, Transmission, and Distribution — Hazardous Energy Control (Lockout/Tagout) Procedures.”

H.1.2.16 Other Publications.

H.1.2.16.1 References for Annex D.

1. International Electrotechnical Commission (IEC), “Electrical Energy Storage,” White Paper, Geneva/Switzerland, pp. 17–34, December 2011.

2. Rastler, D., “Electricity Energy Storage Technology Option,” Electric Power Research Institute, December 2010.

3. Doetsch, C., “Electrical energy storage from 100 kW—State of the art technologies, fields of use,” 2nd International Renewable Energy Storage Conference, Bonn, Germany, November 2007.

4. Xie, S., and L. S. Wang, “Industry Trends — Issue 9,” China Energy Storage Alliance, January 2012.

5. “ADELE — Adiabatic Compressed-Air Energy Storage (CAES) for Electricity Supply,” RWE; “SustainX's ICAES,” SustainX; and “General Compression, Who We Are,” General Compression.

6. Nakhamkin, M., “Novel Compressed Air Energy Storage Concepts,” developed by Energy Storage and Power Consultants (ESPC) and presented to EESAT, May 2007.

7. Inage, Shin-ichi, “Prospects for Large-Scale Energy Storage in Decarbonised Grids,” International Energy Agency, Report, 2009.

8. Schossig, P., “Thermal Energy Storage,” 3rd International Renewable Energy Storage Conference, Berlin, Germany, November 2012.

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12. Bullough, C., “Advanced Adiabatic Compressed Air Energy Storage for the Integration of Wind Energy,” European Wind Energy Conference and Exhibition, London, GB, November 2004.

H.1.2.16.2 References for Annex F.

H.1.2.16.2.1 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code* , 2000, 2003, 2006, 2009, 2012, 2015, and 2018 editions.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems* , 2015 edition.

“Lithium Ion Batteries Hazard and Use Assessment,” Fire Protection Research Foundation, July 2011.

“Lithium Ion Batteries Hazard and Use Assessment — Phase IIB — Flammability Characterization of Li-ion Batteries for Storage Protection,” Fire Protection Research Foundation, April 2013.

“Lithium Ion Batteries Hazard and Use Assessment — Phase III,” Fire Protection Research Foundation, November 2016.

H.1.2.16.2.2 ICC Publications.

International Code Council, 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001.

International Building Code (IBC), 2000, 2003, 2009, 2012, and 2015.

International Fire Code (IFC), 2000, 2003, 2006, 2009, 2012, 2015, and 2018.

International Residential Code , 2018.

Uniform Fire Code (UFC), 1994 and 1997.

H.1.2.16.2.3 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

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

H.1.2.16.3 Other Publications.

DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020.

Marioff Corporation—Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms,” August 2015.

“Fire Safety Testing Data Analysis Supplement for NYC Outdoor ESS,” NY Solar Map, City University of New York (CUNY). https://nysolarmap.com/media/2041/fire-safety-testing-data-analysis-supplement-for-nyc-outdoor-ess_v1.pdf

Statement of Problem and Substantiation for Public Comment

This input is related to PC 349. If PC 349 is accepted, it references these standards, which should then be included here in Annex H.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	annex A text that references these standards
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	

Related Item

- CI-160

Submitter Information Verification

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Public Comment No. 350-NFPA 855-2024 [Section No. H.1.2.6]

H.1.2.6 IEC Publications.

International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 60079-29-1, *Explosive atmospheres — Gas detectors — Performance requirements of detectors for flammable gases* , 2007.

IEC 60812, *Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA)*, 2006.

IEC 61025, *Fault tree analysis (FTA)*, 2006.

IEC 61508-SER, *Electronic Functional Safety Systems Package — All Parts*, 2010.

IEC 61511-SER, *Functional safety — Safety instrumented systems for the process industry sector — All Parts*, 2016, revised 2017.

IEC 62990-1, Workplace atmospheres *— Gas detgectors — Performance requirements of detectors for toxic gases* , 2019.

Statement of Problem and Substantiation for Public Comment

These references were added in PC-349, so if that PC is accepted, these need to be added here.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	Annex text that references these documents added here to Annex H
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	

Related Item

- CI-160

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Public Comment No. 280-NFPA 855-2024 [Section No. H.1.2.13]

H.1.2.13 UL Publications.

~~Underwriters Laboratories~~ ULSE Inc., ~~333 Pfingsten Road, Northbrook, IL 60062-2096.~~ 1603 Orrington Avenue, Evanston, IL 60201

UL 268, *Smoke Detectors for Fire Alarm Systems*, 2016, revised 2023.

UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021.

UL 1642, *Lithium Batteries*, 2020, revised 2022.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2023.

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UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020.

ANSI/~~UL 2775~~ CAN/UL/ULC 2775 , *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019, revised 2022 .

UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised ~~2019~~ 2023 .

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2014, revised ~~2019~~ 2021 .

ANSI/ CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

ANSI/ CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.

UL Solutions Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 9540B, Outline of Investigation for Large-scale Fire Test for Residential Battery Energy Storage Systems, 2024.

Statement of Problem and Substantiation for Public Comment

Update standard title and dates

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 96-NFPA 855-2024 [Section No. 2.3.9]	update UL standard and date references

Related Item

- FR-116

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Public Comment No. 332-NFPA 855-2024 [Section No. H.1.2.13]

H.1.2.13 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 268, *Smoke Detectors for Fire Alarm Systems*, 2016, revised 2023.

UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021.

UL 1642, *Lithium Batteries*, 2020, revised 2022.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2023.

UL 1778, *Uninterruptible Power Systems*, 2014, revised 2023.

CAN/UL 1973, *Batteries for Use in Stationary and Motive Auxiliary Power Applications,* 2022.

CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2022.

UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020.

~~ANSI/~~ UL 2775, ~~Standard for~~ *Fixed Condensed Aerosol Extinguishing System Units,* 2019.

UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019.

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2014, revised 2019.

CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

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

CAN/UL 9540B, Outline of Investigation for Large Scale Fire Test for Residential Battery Energy Storage Systems, 2024.

Statement of Problem and Substantiation for Public Comment

Updated standard short title and remove ANSI as a common term to UL Standards. Added UL 9540B as a consideration provided PC 313 is resolved as a second revision.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 329-NFPA 855-2024 [Section No. 2.3.9]	

Related Item

• FR-57 • PC-313

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Public Comment No. 351-NFPA 855-2024 [Section No. H.1.2.13]

H.1.2.13 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 268, *Smoke Detectors for Fire Alarm Systems*, 2016, revised 2023.

UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021.

UL 1642, *Lithium Batteries*, 2020, revised 2022.

UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2023.

UL 1778, *Uninterruptible Power Systems*, 2014, revised 2023.

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CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2022.

UL 2075 (ULC-Can-S588), *Gas and Vapor Detectors and Sensors* , 2013, revised 2023.

UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020.

ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019.

UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019.

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements*, 2014, revised 2019.

CAN/UL 9540, *Energy Storage Systems and Equipment*, 2023.

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

Statement of Problem and Substantiation for Public Comment

This is a new document referenced in PC-349. If PC-349 is accepted, this needs to be added here.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	annex text that references this standard
Public Comment No. 349-NFPA 855-2024 [Section No. A.9.6.6.1.5.4]	

Related Item

- CI-160

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Public Comment No. 78-NFPA 855-2024 [Section No. H.1.2.16.2.2]

H.1.2.16.2.2 ICC Publications.

International Code Council, ~~500 New Jersey Avenue~~ 200 Massachusetts Ave , NW, ~~6th Floor~~ Suite 250 , Washington, DC 20001.

International Building Code (IBC), 2000, 2003, 2009, 2012, ~~and 2015~~ 2015, 2018, 2021, and 2024 .

International Fire Code (IFC), 2000, 2003, 2006, 2009, 2012, 2015, 2018, 2021, and ~~2018~~ 2024 .

International Residential Code, 2018 and 2021 .

Uniform Fire Code (UFC), 1994 and 1997.

Statement of Problem and Substantiation for Public Comment

The updated address is the ICC Headquarters address listed on the ICC webpage.
https://www.iccsafe.org/about/contact-icc/

The updated versions for the IFC, IBC, and IRC are the currently available ones on the ICC webpage.
https://shop.iccsafe.org/

Related Item

- First Revision No. 58

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