# 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.

**Attendees**

**Committee Members:**

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| ✓ | **Biggins, James** | Chair | CAC Specialty - Natural Resources |
| | **Antman, Rotem** | Principal | Code Fire & Safety Engineering |
| ✓ | **Ashton, Curtis** | Principal | American Power Systems/ East Penn |
| | **Back, Gerard** | Principal | JENSEN HUGHES |
| * | **Bartling, Brandon** | Principal | 3M Company |
| * | **Beach, Denise** | Principal | FM Global |
| * | **Bekele, Zekarias** | Principal | CSA Group |
| * | **Biteau, Hubert** | Principal | Code Red Consultants, LLC |
| * | **Buirch, William** | Principal | Edison Electric Institute |
| * | **Cantor, William** | Principal | IEEE-IAS/PES JTCC |
| * | **Douglas, Stephen** | Principal | QPS Evaluation Services Inc. |
| ✓ | **Fok, Kevin** | Principal | LG Energy Solution Michigan, Inc. |
| * | **Gerczynski, Kara** | Principal | International Association of Fire Chiefs |
| ✓ | **Hayes, Paul** | Principal | The Hiller Companies/American Fire |
| ✓ | **Hill, Darryl** | Principal | International Brotherhood of Electrical |
| * | **Hillaert, John** | Principal | MPR Associates Inc. |
| ✓ | **Ingram, Jonathan** | Principal | Carrier/UTC |
| ✓ | **Jasutis, Gary** | Principal | Sargent & Lundy, LLC. |
| ✓ | **Kennedy, Chad** | Principal | National Electrical Manufacturers |
| * | **Knedlhans, Jason** | Principal | Peregrine Energy Solutions, LLC |
| | **Kozak, Paul** | Principal | Consultant |
| | **Krcmar, Angela** | Principal | Firetrace International |
| ✓ | **Marrero, Jose'** | Principal | Southern Company |
| * | **McKinch, Terrance** | Principal | Signal Energy Constructors |
| * | **McNamara, Timothy** | Principal | Fire Department City of New York |
| * | **Mirek, Mark** | Principal | Brown & Brown, Inc./Beecher Carlson LLC |

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| ✓ | **Paiss, Matthew** | Principal | Pacific Northwest National Laboratory |
| ✓ | **Perry, Justin** | Principal | Dominion Energy |
| ✓ | **Picard, Charles** | Principal | Tesla |
| * | **Pruett, Scot** | Principal | Black & Veatch Corporation |
| | **Rhodes, Allan** | Principal | Fluence Energy |
| ✓ | **Rogers, Paul** | Principal | International Association of Fire Fighters |
| ✓ | **Ryder, Noah** | Principal | Fire & Risk Alliance |
| * | **Sanders, Seth** | Principal | Amber Kinetics |
| * | **Scholl, Brian** | Principal | Phoenix Fire Department |
| ✓ | **Schubert, Randy** | Principal | Alliance for Telecommunications Industry |
| ✓ | **Schwalb, LaTanya** | Principal | UL Solutions |
| ✓ | **Skoskiewicz, Andrzej** | Principal | Stem, Inc. |
| | **Stone, Nicholas** | Principal | Eaton Corporation |
| * | **Sun, K.** | Principal | Hartford Steam Boiler (HSB) Munich Re- |
| * | **Tang, Liang** | Principal | China Energy Storage Alliance |
| ✓ | **Towski, Chris** | Principal | Fire Prevention Association of |
| ✓ | **Warner, Nick** | Principal | ESRG Energy Safety Response |
| ✓ | **Woodfin, Ronald** | Principal | TetraTek, Inc./AES Corporation |
| | **Wu, Cavic** | Principal | Great Power Energy & Technology |
| | **Youngs, Daniel** | Principal | Saft America Batteries |
| * | **Zornes, Tom** | Principal | Fire Suppression Systems Association |
| * | **Barrett, Jim** | Voting Alternate | Enel X North America/ Demand Energy |
| * | **Davidson, Robert** | Voting Alternate | Davidson Code Concepts, LLC |
| ✓ | **Armstrong, John** | Alternate | Dominion Energy |
| * | **Balash, Gary** | Alternate | East Penn Manufacturing Company |
| * | **Bartlett, Nicholas** | Alternate | National Renewable Energy Laboratory |
| | **Bensen, Thomas** | Alternate | Bensen Fire & Safety Consulting, Ltd. |
| * | **Conzen, Jens** | Alternate | JENSEN HUGHES |
| * | **DeCrane, Sean** | Alternate | International Association of Fire Fighters |
| * | **Dein, Eric** | Alternate | Black & Veatch |
| | **Ditch, Benjamin** | Alternate | FM Global |
| | **Eaves, Dennis** | Alternate | Beecher Carlson |

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| ✓ | **Francis, Christina** | Alternate | Tesla |
| ✓ | **Grahor, Lou** | Alternate | Eaton Corporation |
| ✓ | **Hattier, Robert** | Alternate | International Brotherhood of Electrical |
| | **Hopper, Howard** | Alternate | UL Solutions |
| * | **Hoyt, Jennifer** | Alternate | Code Red Consultants |
| | **Johnson, Nick** | Alternate | 3M Company |
| | **Kellaher, Mark** | Alternate | Signal Energy Constructors |
| * | **Kluge, Richard** | Alternate | Alliance for Telecommunications Industry |
| ✓ | **Lang, Scott** | Alternate | National Electrical Manufacturers |
| ✓ | **Leber, Jody** | Alternate | CSA Group |
| ✓ | **Maiz, Michael** | Alternate | Fire Department City of New York |
| ✓ | **Natale, Anthony** | Alternate | Edison Electric Institute |
| ✓ | **O'Brian, Michael** | Alternate | International Association of Fire Chiefs |
| * | **Schimanek, Ralf** | Alternate | Fluence Energy |
| ✓ | **Searles, Christopher** | Alternate | IEEE-IAS/PES JTCC |
| ✓ | **Stoops, Morris** | Alternate | Carrier/UTC |
| ✓ | **Subbarao, Leo** | Alternate | Fire Prevention Association of |

**Guests:**

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| *Christina Hoffman | Plus Power |
| *Chad Sievers | NY DOS |
| *Andrew Early | Burns & McDonnell |
| *Steve Edley | Zinc 8 Energy Solutions |
| 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 |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.5.3.1.1.1<br><br>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<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 9.5.3.1.1.2<br><br>ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following:<br><br>(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.<br><br>(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.<br><br>(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).<br><br>(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.<br><br>(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. | | |

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| | (6) Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted when approved by the AHJ.<br><br>(7) Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes.<br><br>(8) A thermal image or radiant energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS.<br><br>(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<br><br>ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following:<br><br>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.<br>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.<br>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).<br>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.<br>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.<br>6. Installations on rooftops over 75 ft (23 m) in height above grade shall be permitted when approved by the AHJ.<br>7. Access, service space, guards, and handrails shall be provided where required by the local building and mechanical codes.<br>8. A radiant energy-sensing fire detection system complying with Section 4.8 shall be provided to protect the ESS.<br>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<br>☐ Resolve |
| Proposed Text (PI) | 15.3.1 ESS Spacing.<br><br>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.<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 15.12* Test Reports<br><br>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.<br><br>A.15.12<br><br>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 | | |

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| | 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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.13 Fire and Explosion Testing.<br><br>15.13.1*<br><br>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.<br><br>A.15.13.1<br><br>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 | | |

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| | 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.<br><br>15.13.1.1<br><br>The complete UL 9540A or equivalent test report shall be provided to the Authority Having Jurisdiction, including the cell, module, and unit level.<br><br>15.13.1.2<br><br>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.<br><br>15.13.1.3<br><br>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.<br><br>15.13.1.4*<br><br>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.<br><br>A.15.13.1.4<br><br>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.<br><br>15.13.1.5<br><br>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.<br><br>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.<br><br>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 |

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| | 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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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. |

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| | 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<br><br>☐ Resolve |
| Proposed Text (PI) | ~~4.12~~ 9.6.5.6*<br><br>A.~~4.12~~ 9.6.5.6<br><br>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.<br><br>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.<br><br>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.<br><br>~~4.12.1~~ 9.6.5.6.3* *<br><br>ESS installed within a room, building, ESS cabinet, or ESS walk-in unit shall be provided with one of the following:<br><br>(1) Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69<br>(2) Deflagration venting installed and maintained in accordance with NFPA 68<br><br>A.~~4.12.1~~ 9.6.5.6.3*<br><br>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.<br><br>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 | | |

<table>
<tr><td></td><td>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.<br><br>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:<br><br>(1) Control of oxidant concentration<br>(2) Control of combustible concentration<br>(3) Pre-deflagration detection and control of ignition sources<br>(4) Explosion suppression<br>(5) Active isolation<br>(6) Passive isolation<br>(7) Deflagration pressure containment<br>(8) Passive explosion suppression<br><br>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.<br><br>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.<br><br>~~4.12.1.1~~ 9.6.5.6.1.1<br><br>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.<br><br>~~4.12.1.2~~ 9.6.5.6.4*<br><br>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.</td></tr>
<tr><td>First Revision Text (FR)</td><td>See below for revised text.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td>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</td></tr>
</table>

<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.<br><br>Changes Moved from 4.12 to Chapter 9</td></tr>
<tr><td>Response<br>(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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6* Explosion Control.<br><br>9.6.5.6.1<br><br>Where required elsewhere in this standard, explosion prevention or deflagration venting shall be provided in accordance with this section.<br><br>9.6.5.6.1.1<br><br>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.<br><br>9.6.5.6.1.2<br><br>Explosion control shall not be required for the following:<br><br>(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<br><br>(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<br><br>(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<br><br>(4) ~~Lead-acid and Ni-Cd batteries listed in accordance with UL 1973~~<br><br>(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<br><br>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.

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| | (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.<br><br>(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:~~<br><br>~~(a) A trouble signal upon failure of the gas detection system~~<br><br>~~(b) An alarm signal if flammable gas concentration exceeds 10 percent of the LFL~~<br><br>9.6.5.6.8<br><br>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:<br><br>(1) For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment.<br><br>(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.<br><br>(3) The gas detection system shall be designed to activate on detection of flammable gas in either aisle/subcompartment.<br><br>9.6.5.6.9<br><br>The protection design shall demonstrate that deflagrations are not propagated to interconnected or adjacent cabinets, enclosures, or rooms. |
| First Revision Text (FR) | See below for revised text. |
| Statement (technical reason for FR) | 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. |
| Response (technical reason for not making some changes or for resolving) | Power requirements resolved and addressed under separate PI's,<br><br>Section 9.6.5.6.7 was adjusted under PI 79,253,104,129 to include other committee inputs<br><br>Section 9.6.5.6.6 was deleted under other committee inputs. |

| A.9.6.5.6 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 150 | 144 | ☒ Create First Revision<br><br>☐ Resolve |

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|---|---|
| Proposed Text (PI) | A.9.6.5.6<br><br>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 |

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| | other things, these gases present an explosion hazard that needs to be mitigated. Explosion control is provided to mitigate this hazard.<br><br>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.<br><br>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.<br><br>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. |
| First Revision Text (FR) | See below for revised text. |
| Statement (technical reason for FR) | 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. |
| Response (technical reason for not making some changes or for resolving) | |

| 9.6.5.6.1 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 337 | None | ☒ Create First Revision<br><br>☐ Resolve |

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| Proposed Text (PI) | 9.6.5.6.1<br><br>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. |
| First Revision Text (FR) | See below for revised text. |
| Statement (technical reason for FR) | Additional input and clarification for abnormal conditions. Also removed Deflagration venting as this is a subset of Explosion control. |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.1.1<br>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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.1.2<br>Explosion control shall not be required for the following:<br>(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<br>(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<br>(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 | | |

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| | (4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973 used in system 600Vdc or less.<br><br>(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) | Corrected the term "uninterruptable" as a typo. |
| Response (technical reason for not making some changes or for resolving) | Item 4 was deleted for better clarification of item 5. |

| 9.6.5.6.1.2 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 189 | 253, 171, 72 | ☐ Create First Revision<br><br>☒☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | 9.6.5.6.1.2<br><br>Explosion control shall not be required for the following:<br><br>(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<br><br>(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<br><br>(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<br><br>(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973<br><br>(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) | |
| Response (technical reason for not making some | Modified as part of PI 72 |

<table>
<tr><td>changes or for resolving)</td><td colspan="3"></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>72, part 253 189</td><td>171, 189</td><td>☒ Create First Revision<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.1.2<br><br>Explosion control following this standard shall not be required for the following:<br><br>(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<br><br>(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.<br><br>(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.<br><br>(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973<br><br>(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">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.</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">9.6.5.6.1.2</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>Carry over from PI 27, part 253,</td><td>253, 171, 72, 189</td><td>☒ Create First Revision<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.1.2<br><br>Explosion control shall not be required for the following:<br><br>(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</td></tr>
</table>

| | | | |
|---|---|---|---|
| | communications utilities located in building spaces or walk-in units used exclusively for such installations that comply with NFPA 76<br>(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<br>(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<br>(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973<br>(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) | Remove Safe as not defined. | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| New 9.6.5.6.1.3 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 262 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.1.3<br>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. | | |
| First Revision Text (FR) | See below for revised text. | | |
| Statement (technical reason for FR) | 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. | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| 9.6.5.6.2 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 338 | None | ☐ Create First Revision<br>☒ Resolve |

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|---|---|---|---|
| Proposed Text (PI) | ~~9.6.5.6.2~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.3*<br><br>~~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:~~<br><br>~~(1)~~ Explosion prevention systems designed, installed, operated, maintained, and tested in accordance with NFPA 69<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | A.9.6.5.6.3<br><br>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.<br><br>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.<br><br>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:<br><br>(1) Control of oxidant concentration<br>(2) Control of combustible concentration<br>(3) Pre-deflagration detection and control of ignition sources<br>(4) Explosion suppression<br>(5) Active isolation<br>(6) Passive isolation<br>(7) Deflagration pressure containment<br>(8) Passive explosion suppression<br><br>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.<br><br>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. |

| | | | |
|---|---|---|---|
| Statement<br>(technical reason for FR) | 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. | | |
| Response<br>(technical reason for not making some changes or for resolving) | | | |
| 9.6.5.6.4 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 75 | 144, 253 | ☒~~☐~~ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.4*<br><br>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. | | |
| First Revision Text (FR) | See below for revised text. | | |
| Statement<br>(technical reason for FR) | 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. | | |
| Response<br>(technical reason for not making some changes or for resolving) | | | |
| New 9.6.5.6.4 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 339 | 253, 76 | ☒~~☐~~ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.4<br><br>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.<br><br>9.6.5.6.~~4~~5*<br><br>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.<br><br>~~9.6.5.6.5~~ | | |

<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 rowspan="2">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>76</td><td>253</td><td>☒ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.5*<br><br>~~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.<br><br>A.9.5.6.5<br><br>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 rowspan="2">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>341</td><td>253</td><td>☐ Create First Revision<br>☒ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.6*</td></tr>
</table>

| | |
|---|---|
| | 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:<br>(1) The container shall be provided with explosion control complying with 9.6.5.6.3.<br>(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. |
| 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) | Because of change in prior sections, this section has been deleted. |

| 9.6.5.6.6 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 77 | 253, 341 | ☒ Create First Revision<br>☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | ~~9.6.5.6.6*~~<br>~~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:~~<br>~~(1) The container shall be provided with explosion control complying with 9.6.5.6.3.~~<br>~~(2) Combination of the container and cabinets shall be tested together to show compliance with 9.6.5.6.1.1.~~ |
| First Revision Text (FR) | See below for revised text. |
| Statement (technical reason for FR) | With edits in prior sections, this section is no longer needed. Explosion requirements for a box in a box have been updated. |
| Response (technical reason for not making some changes or for resolving) | |

| 9.6.5.6.7 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 104, 79, 253, 129, | ~~253, 129, 79~~ | ☒ Create First Revision<br>☐ Resolve |

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7<br><br>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:<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(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:<br><br>(a) A trouble signal upon failure of the gas detection system<br><br>(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<br>(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<br>(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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7<br><br>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:<br><br>(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>
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<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.<br><br>(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.<br><br>(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.<br><br>(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:<br><br>(a) A trouble signal upon failure of the gas detection system<br><br>(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<br>(technical reason for FR)</td><td colspan="3">See PI 104</td></tr>
<tr><td>Response<br>(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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7<br><br>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:<br><br>(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.<br><br>(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.<br><br>(3) The gas detection <s>system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power</s> .<br><br>(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>
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| | | | |
|---|---|---|---|
| | (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:<br>(a) A trouble signal upon failure of the gas detection system.<br>(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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.8<br>Compartmentalization created by cold and hot aisle arrangements within the ESS enclosure shall be addressed in accordance with the following:<br>(1) For NFPA 69 designs, the performance of ventilation systems shall be independently verified for a thermal runaway event in either aisle/subcompartment.<br>(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.~~<br>(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<br><br>☒ Resolve |
| Proposed Text (PI) | 9.6.5.6.8 Reliable Power Requirements<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.9<br><br>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)<br><br>A.9.6.5.6 (PI 150)<br><br>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<br><br>☒ 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<br><br>☐ Resolve |
| Proposed Text (PI) | G.2.3.3<br><br>The following similar hazards are present during abnormal operation, but should be considered more likely as a result of upset or damage:<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(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. | | |

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| | (5) *Toxic particulate exposure*: In addition to gases, some of the particulates produced in a battery fire may be toxic.<br><br>(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<br><br>The following similar hazards are present during abnormal operation, but should be considered more likely as a result of upset or damage:<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(5) *Toxic particulate exposure*: In addition to gases, some of the particulates produced in a battery fire may be toxic.<br><br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | G.3.1.1 | | |

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| | 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<br><br>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<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | G.4.3.1.1.5 Water-Based Suppression System.<br><br>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.<br><br>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<br>☐ Resolve |
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**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

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| | 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.<br>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<br>3. Minimum space separation has been provided from the ESS to surrounding noncombustible objects to limit the potential for damage<br>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)<br>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.<br>6. Adequate building component rating is provided to withstand the expected intensity and duration of an ESS fire event.<br><br>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<br><br>☒☐ Resolve |
| Proposed Text (PI) | G.6.1.3.2 Standards.<br><br>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.<br><br>For more information on water mist systems, see NFPA 750. | | |

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| 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<br>☒☐ Resolve |
| Proposed Text (PI) | G.6.1.3.3<br>For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following:<br>(1) DNVGL Battery Safety Joint Development Project Report, "Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression."<br>(2) Marioff Corporation – Fire Test Summary #57/BR/AUG15, "HI-FOG® Systems for Protection of Li-ion Rooms."<br>(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<br>☒☐ Resolve |
| Proposed Text (PI) | G.6.1.3.3<br>For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following: | | |

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| | (1) DNVGL Battery Safety Joint Development Project Report, "Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression."<br><br>(2) Marioff Corporation – Fire Test Summary #57/BR/AUG15, "HI-FOG® Systems for Protection of Li-ion Rooms."<br><br>(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.<br><br>For more information on fire and explosion testing for Li-ion battery fire suppression with water mist, see the following:<br><br>1. DNVGL Battery Safety Joint Development Project Report, "Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression."<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | G.6.5 Encapsulation. ~~(Reserved)~~<br><br>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.<br><br>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 | |

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| | other explosive off-gases, rendering them nonexplosive. Encapsulating technology reduces the toxicity of HF gas exposure to humans.<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | G.7.3.1<br><br>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.<br><br>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. | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | G.7.3.2 Smoke Detection.<br><br>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.<br><br>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<br><br>☐ Resolve |
|---|---|---|---|
| Proposed Text (PI) | G.7.3.3 Flame Detection.<br><br>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.<br><br>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<br><br>☐ Resolve |

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| Proposed Text (PI) | G.7.3.4 Heat Detection.<br><br>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.<br><br>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.<br><br>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.<br><br>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<br><br>☐ Resolve |

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| Proposed Text (PI) | G.7.3.5 Thermal Imaging—Temperature Monitoring and Early Warning Fire Detection.<br><br>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.<br>~~7.3.5 Thermal Imaging—Temperature Monitoring and Early Warning Fire Detection.~~<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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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| | 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~~. The thermal imager may be combined with a visual camera that can provide situational awareness. Thermal imaging ~~It~~ can be used internal or external to the BESS. First responders can use the images to access the internal condition of the ESS.<br><br>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.<br><br>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.<br><br>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.<br><br>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. |
| 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) | |

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| G.7.3.6.1 | 327 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | G.7.3.6.1 Cell-Level Event.<br><br>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 ($CO_2$), carbon monoxide (CO), hydrogen ($H_2$) and VOCs. The gas temperature during cell venting is generally around 100-150°C.<br><br>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 ($CH_4$, $C_2H_4$, $C_2H_6$, 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.<br><br>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.<br><br>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.<br><br>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.<br><br>~~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. | | |

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| First Revision Text (FR) | G.7.3.6.1 Cell-Level Event.<br><br>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 ($CO_2$), carbon monoxide (CO), hydrogen ($H_2$) and VOCs. The gas temperature during cell venting is generally around 100-150°C.<br><br>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 ($CH_4$, $C_2H_4$, $C_2H_6$, 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.<br><br>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.<br><br>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.<br><br>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 |

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| | purpose of "off-gas detection" from the incipient stages of a lithium-ion battery thermal runaway.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | G.7.3.6.3 Effects on $H_2$ Gas Detection After Suppression Discharge.<br><br>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 $H_2$.<br><br>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.<br><br>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.<br><br>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 | | |

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| | determine concentration level or LFL. LIBs also release other HCs during failure. These other HCs will be burned on the sensor and recognized as $H_2$.<br><br>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.<br><br>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 |
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| G.7.3.7.2 | 50 | None | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | G.7.3.7.2 High-Risk Equipment Protection.<br><br>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:<br><br>(1) Those that are likely to promote a fast developing fire.<br><br>(2) Those that will generate corrosive and toxic ~~gas species~~ and highly toxic emissions.<br><br>(3) Those whose unnecessary shutdown would result in substantial network service losses.<br><br>(4) System losses that could create conditions for battery failure such as HVAC or BMS system loss. | | |

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| | Sampling location considerations are often similar to those for cabinet protection and include the following:<br>(1) Sampling should be conducted within or around high-risk equipment for the earliest possible detection of smoke.<br>(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.<br>(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.<br><br>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:<br><br>1. Those that are likely to promote a fast developing fire.<br>2. Those that will generate corrosive and toxic and highly toxic emissions ~~gas species~~.<br>3. Those whose unnecessary shutdown would result in substantial network service losses.<br>4. System losses that could create conditions for battery failure such as HVAC or BMS system loss.<br><br>Sampling location considerations are often similar to those for cabinet protection and include the following:<br><br>1. Sampling should be conducted within or around high-risk equipment for the earliest possible detection of smoke.<br>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.<br>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 |
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| New G.8 | 64 | None | ☒☐ Create First Revision<br><br>☐ 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.

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| G.11.3 | 61 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | G.11.3 Guidelines.<br><br>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.<br><br>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. | | |
| First Revision Text (FR) | G.11.3 Guidelines.<br><br>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.<br><br>Handover procedures for potentially damaged systems should be developed for fire departments to ensure the timely response of a qualified person ~~technical~~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. | | |

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| Statement<br>(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<br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | G.11.4 Suppression Systems.<br><br>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.<br><br>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. | | |
| First Revision Text (FR) | G.11.4 Suppression Systems.<br><br>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 | | |

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| | 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.<br><br>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 person ~~and trained individual~~ in ESS should be made available to assist the firefighters in the event of damage to an installed system. |
| 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.11.5 | 51 | None | ☒ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | G.11.5 Overheated Batteries.<br><br>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.<br><br>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. | | |

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| | 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.<br><br>Proper response to electrochemical ESS fires should include the following procedures and steps:<br><br>(1) System isolation and shutdown<br>(2) Hazard confinement and exposure protection<br>(3) Fire suppression<br>(4) Controlled ventilation |
| First Revision Text (FR) | G.11.5 Overheated Batteries.<br><br>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.<br><br>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.<br><br>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.<br><br>Proper response to electrochemical ESS fires should include the following procedures and steps:<br><br>1. System isolation and shutdown<br>2. Hazard confinement and exposure protection<br>3. Fire suppression<br>4. Controlled ventilation |
| 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. |

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| Response<br>(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<br>☐ Resolve |

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| Proposed Text (PI) | G.11.7.3 Suppression Tactics.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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 |

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| | 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. |
| First Revision Text (FR) | G.11.7.3 Suppression Tactics.<br><br>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.<br><br>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.<br><br>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.<br><br>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 |

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| | 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.<br><br>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. |
| 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<br><br>☐ Resolve |

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| Proposed Text (PI) | G.11.8.5 Types of Hazards Once a Fire has Started.<br><br>Fire, explosions, toxic ~~gases~~ <u>and highly toxic emissions</u>, 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.<br><br>Fire, explosions, toxic <u>and highly toxic emissions</u>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | Fire Risk Assessment (FRA).<br><br>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).<br><br>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) | | | |



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| New Definition | 65# | None | ☒ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | **Failure Modes and Effects Analysis (FMEA)**<br><br>• **"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.**<br>• **"Effects analysis" refers to studying the consequences of those failures.**<br><br>**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)<br><br>• "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.<br>• "Effects analysis" refers to studying the consequences of those failures. | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | 4.2.1.3<br>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:<br>(1) Fire and explosion testing data in accordance with 9.1.5<br>(2) Hazard mitigation analysis (HMA) in accordance with Section 4.4<br>(3) Calculations or modeling data to determine compliance with explosion control in accordance with 9.6.5.6.3<br>(4) Other test data, evaluation information, or calculations as required elsewhere in this standard | | |
| First Revision Text (FR) | 4.2.1.3<br>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:<br>1. Fire and explosion testing data in accordance with 9.1.5<br>2. Hazard mitigation analysis (HMA) in accordance with Section 4.4<br>3. Calculations or modeling data to determine compliance with ~~NFPA 68 and NFPA 69~~ explosion control in accordance with 9.6.5.6.3<br>4. Other test data, evaluation information, or calculations as required elsewhere in this standard | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 4.4.2.1*<br><br>The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:<br>(1) A thermal runaway or mechanical failure condition in a single ESS unit<br>(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)<br>~~Failure of a required protection system including, but not limited to, ventilation (HVAC), exhaust ventilation, smoke detection, fire detection, fire suppression, or gas detection~~<br>(3) As identified in a site level Fire Risk Assessment (FRA) or a Site level FMEA. | | |
| First Revision Text (FR) | 4.4.2.1*<br><br>The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:<br>1. A thermal runaway or mechanical failure condition in a single ESS unit<br>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)<br>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.<br><br>A.4.4.2.1<br><br>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. | | |

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| Statement (technical reason for FR) | 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. | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| 4.4.2.1 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 110# | ~~68~~ | ☐ Create First Revision<br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 4.4.2.1*<br><br>The hazard mitigation analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:<br><br>(1) A thermal runaway or mechanical failure condition in a single ESS unit<br><br>(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<br><br>(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 | | |
| First Revision Text (FR) | | | |
| Statement (technical reason for FR) | | | |
| Response (technical reason for not making some changes or for resolving) | 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. | | |



| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| New 4.4.2.3 | 69# | None | ☒~~☐~~ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 4.4.2.3*<br><br>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. | | |

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| | A.4.4.2.3<br><br>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*<br><br>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.<br><br>A.4.4.2.3<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.1.5.1<br><br>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 | | |

<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"></td></tr>
<tr><td rowspan="2">9.1.5.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>355#</td><td>263</td><td>☐ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.1.5.1<br>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~~.</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">A.9.1.5.1</td><td>All PIs used for FR or Resolve</td><td>Other PIs that propose revisions for this section</td><td>MOTION</td></tr>
<tr><td>356#</td><td>37</td><td>☐ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.9.1.5.1<br>~~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.~~<br><u>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</u>~~.~~</td></tr>
</table>

| | | | |
|---|---|---|---|
| | 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.<br><br>**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.<br><br>**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<br><br>**Unit level test**- All of the following results are obtained:<br><br>1. Target BESS temperatures less than cell surface temperature at gas venting, and meets the heat flux limits for means of egress.<br>2. Temperature increase of target walls less than 97 °C (175 °F)<br>3. No explosion hazards exhibited by the product<br>4. No flaming beyond outer dimensions of BESS unit (indoor, wall mount)<br><br>**Installation level test**– Acceptable performance includes all of the following:<br><br>1. Target BESS temperatures less than cell surface temperature at gas venting, and meets the heat flux limits for means of egress.<br>2. Temperature increase of target walls less than 97 °C (175 °F)<br>3. The flame indicator does not propagate flames beyond the width of the initiating BESS<br>4. No flaming outside the test room, and meets the heat flux limits for the means of egress.<br><br>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 |

| | | | |
|---|---|---|---|
| | 263, 355, 37,356# | 356 | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | A.9.1.5.1<br><br>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. | | |
| First Revision Text (FR) | See below for revised text. | | |
| 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) | | | |
| First Revision Text (FR) | 9.1.5.1*<br><br>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.<br><br>A.9.1.5.1<br><br>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 | | |

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)

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|---|---|
| | 3. No explosion hazards exhibited by the product<br><br>4. No flaming beyond outer dimensions of BESS unit (indoor, wall mount)<br><br>**Installation level test**– Acceptable performance includes all of the following:<br><br>1. Target BESS temperatures less than cell surface temperature at gas venting and meets the heat flux limits for means of egress.<br><br>2. Temperature increase of target walls less than 97 °C (175 °F)<br><br>3. The flame indicator does not propagate flames beyond the width of the initiating BESS<br><br>4. No flaming outside the test room and meets the heat flux limits for the means of egress.<br><br>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<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.1.5.1.2.1*<br><br>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.<br><br>A. 9.1.5.1.2.1<br><br>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. | | |

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|---|---|
| First Revision Text (FR) | 9.1.5.1.2* <br><br> ~~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.~~ <br> 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. <br><br> A. 9.1.5.1.2.1 <br><br> 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. <br><br> 9.1.5.1.2.1* <br><br> 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. <br><br> **9.1.5.1.2.2** <br><br> 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<br><br>☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | 9.1.5.1.4*<br><br>The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets.<br><br>A.9.1.5.1.4<br><br>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*<br><br>The testing shall include evaluation of deflagration mitigation measures when designed into ESS cabinets.<br><br>A.9.1.5.1.4<br><br>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.<br><br>9.1.5.1.4.1<br><br>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<br>☒☐ Resolve |
|---|---|---|---|
| Proposed Text (PI) | A.9.1.5.2<br><br>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<br><br>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<br>☒☐ Resolve |
| Proposed Text (PI) | 9.1.5.2.1*<br><br>The complete test report and its supporting data shall be provided to the AHJ for review and approval.<br><br><u>A.9.1.5.2.1</u><br><br><u>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.</u> | | |
| First Revision Text (FR) | 9.1.5.2.1<br><br>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<br>X☐ Resolve |
| Proposed Text (PI) | 9.1.5.2.2.1*<br>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.<br>A.9.1.5.2.2.1<br>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.<br>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.<br>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<br>☒☐ Resolve |

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|---|---|
| Proposed Text (PI) | 9.1.5.2.3*<br><br>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.<br><br>A.9.1.5.2.3<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.13 Fire and Explosion Testing.<br><br>15.13.1*<br><br>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.<br><br>A.15.13.1<br><br>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.<br><br>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.<br><br>15.13.1.2<br><br>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.<br><br>15.13.1.3<br><br>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.<br><br>15.13.1.4*<br><br>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.<br><br>A.15.13.1.4<br><br>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.<br><br>15.13.1.5<br><br>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<br><br>☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | **Failure Modes and Effects Analysis (FMEA)**<br>• **"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.**<br>• **"Effects analysis" refers to studying the consequences of those failures.**<br>**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)<br>• "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.<br>• "Effects analysis" refers to studying the consequences of those failures.<br>•<br>A.3.3.x<br>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) | 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) |
| Response (technical reason for not making some changes or for resolving) | |
| New Section – CI | **All PIs used for FR or Resolve:** <br>**Other PIs that propose revisions for this section:** <br>**MOTION:** ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | Water Run off and water impacts |
| First Revision Text (FR) | 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.<br><br>**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 |

<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<br>(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response<br>(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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">3.3.14 Hazard Mitigation Analysis (HMA).<br><br>An evaluation of potential energy storage system failure modes and the safety-related consequences attributed to the failures.<br><br>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<br>(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response<br>(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<br>☐ 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<br>☐ Resolve |
| Proposed Text (PI) | See table below | | |

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.<br>*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.<br>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.



| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| 9.5.3.2.6 | 84 | None | ☒ Create First Revision<br>☐ Resolve |

Proposed Text (PI)

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 |

| | |
|---|---|
| | <table><tr><td>Maximum stored energy</td><td>Yes</td><td>9.4.1</td></tr><tr><td>Fire and smoke detection</td><td>Yes[b]</td><td>9.6.1</td></tr><tr><td>Fire control and suppression</td><td>Yes[c]</td><td>9.6.2</td></tr><tr><td>Maximum size</td><td>Yes</td><td>9.5.2.4</td></tr><tr><td>Vegetation control</td><td>Yes</td><td>9.5.2.2</td></tr><tr><td>Means of egress separation</td><td>Yes</td><td>9.5.2.6.1.7</td></tr><tr><td>~~Technology-specific protection~~ Exhaust Ventilation during normal operations*</td><td>Yes</td><td>9.6.5.1</td></tr><tr><td>Spill control*</td><td>Yes</td><td>9.6.5.2</td></tr><tr><td>Neutralization*</td><td>Yes</td><td>9.6.5.3</td></tr><tr><td>Safety Caps*</td><td>Yes</td><td>9.6.5.4</td></tr><tr><td>Thermal Runaway*</td><td>Yes</td><td>9.6.5.5</td></tr><tr><td>Explosion Control*</td><td>Yes</td><td>9.6.5.6</td></tr></table><br>[a] In walk-in units, spacing is not required between ESS units and the walls of the enclosure.<br>[b] Alarm signals are not required to be transmitted to an approved location for mobile ESS deployed 30 days or less.<br>[c] Only required for walk-in units.<br>* 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.<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | ~~9.6.5.1.2 Abnormal Conditions.~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.2 Abnormal Conditions.<br><br>9.6.5.1.2.1<br><br>Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6.<br><br>9.6.5.1.2.2<br><br>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.<br><br>9.6.5.1.2.1<br><br>Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6.<br><br>9.6.5.1.2.2<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.3 Indoor ESS Cabinets.<br><br>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.<br><br>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.<br>.<br>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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.4* Natural Exhaust Ventilation.<br><br>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.<br>.<br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.5<br><br>Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following:<br><br>(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<br><br>(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.<br><br>Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following:<br><br>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<br>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 | | |

| | |
|---|---|
| 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 |
|---|---|---|---|
| 9.6.5.1.5.1 | 332 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.5.~~1~~ 3<br>Mechanical exhaust ventilation shall be either continuous or activated by a gas detection system in accordance with 9.6.5.1.5.4. | | |
| First Revision Text (FR) | 9.6.5.1.5.~~1~~3<br>Mechanical exhaust ventilation shall be either continuous or activated by a gas detection system in accordance with 9.6.5.1.5.4. | | |
| Statement (technical reason for FR) | 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. | | |
| 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 |
|---|---|---|---|
| 9.6.5.1.5.4 | 333 | None | ☒~~☐~~ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.5.4*<br>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:<br>(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. | | |

| | |
|---|---|
| | (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.~~<br><br>(3) The gas-detection system shall be provided with a minimum of 2 hours of standby power.<br><br>(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***<br><br>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:<br><br>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.<br><br>~~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.~~<br><br>~~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.~~<br><br>~~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) | |

| 9.6.5.6.7 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 104 | 253, 129, 79 | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.7<br><br>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:<br><br>(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.<br><br>(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.<br><br>(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.<br><br>(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.<br><br>(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:<br><br>(a) A trouble signal upon failure of the gas detection system<br><br>(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) | | | |
| Response (technical reason for not making some changes or for resolving) | | | |

| 9.6.5.6.7 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 129 | 253, 104, 79 | ☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.6.7<br><br>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 | | |

<table>
<tr><td></td><td colspan="3">be protected by an approved continuous gas detection system that complies with the following:<br><br>(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.<br><br>(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.<br><br>(3) The gas detection system and combustible gas concentration reduction system shall be provided with a minimum of 2 hours of standby power.<br><br>(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.<br><br>(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:<br><br>(a) A trouble signal upon failure of the gas detection system<br><br>(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>79, 253,104,129</td><td>~~253, 104, 129~~</td><td>☒~~☐~~ Create First Revision<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.5.6.7<br><br>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:<br><br>(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.<br><br>(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.<br><br>(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.<br><br>(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:<br><br>(a) A trouble signal upon failure of the gas detection system or the combustible Gas concentration reduction system.<br><br>(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.<br><br>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)**<br><br>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:<br><br>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.<br>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.<br>3. The gas detection system and CGCRS shall be provided with EPSS or SEBSS per ~~s~~Section 4.10.<br>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 .<br>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:<br>    1. ~~(a)~~ A trouble signal upon failure of the gas detection system or the combustible gas concentration reduction system.<br>    2. ~~(b)~~ An alarm signal if flammable gas concentration exceeds 10 percent of the LFL<br><br>**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.<br><br>**9.6.5.6.7.2** The HMA shall include an analysis to ensure survivability of the CGCRS up until fire occurs.<br><br>**9.6.5.6.7.3**<br>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.<br><br>**9.6.5.6.7.2** CGCRS shall meet the test and inspection requirements of NFPA 69 section 15. |
|---|---|

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

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| 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<br>☐ 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<br>☒ Resolve |
| Proposed Text (PI) | ~~4.7.5.4*~~<br>~~For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle.~~ | | |

| | |
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| First Revision Text (FR) | 4.7.5.4*<br><br>For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle.<br><br>A.4.7.5.4<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.4.1<br><br>ESS shall only be installed in the following locations:<br><br>(1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code<br><br>(2) In detached garages and detached accessory structures<br><br>(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<br><br>(4) In enclosed utility closets and storage or utility spaces where approved by the AHJ<br><br>(5) <u>For residential garages, ESS shall not be installed in a location where subject to damage from impact by a motor vehicle.</u> | | |

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| First Revision Text (FR) | 15.8 ~~Protection from Impact.~~<br><br>~~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.<br><br>A.15.8<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | Toxic Gas.<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | Highly Toxic Gas.<br><br>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.<br><br>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] | | |

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|---|---|
| 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<br>☐ Resolve |
| Proposed Text (PI) | Minimum Approach Distance (MAD)<br>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)<br>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.<br>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<br>☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | Toxic Emissions<br>Toxic species (gases, particulate, liquid or solid) released (into the environment where humans may be exposed.<br>A.3.3.x<br>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<br>Toxic chemical species (gases, particulate, liquid or solid) that are released into the environment.<br>A.3.3.x<br>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) | |



| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| 4.6.11 | 35 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 4.6.11* ESS Toxic and Highly Toxic Gas ~~Release~~ Emitted During Normal Use.<br>ESS shall not ~~release~~ emit toxic or highly toxic gases during normal charging, discharging, and use. | | |
| First Revision Text (FR) | See below for revised text. | | |
| Statement (technical reason for FR) | 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”. | | |
| Response (technical reason for | | | |

| | | | |
|---|---|---|---|
| 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<br><br>☐ Resolve |
| Proposed Text (PI) | A.4.6.11<br><br>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.<br><br>ESS shall not ~~release~~ emit toxic or highly toxic gases during normal charging, discharging, and use.<br><br>A.4.6.11<br><br>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<br><br>☐ 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<br>(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.<br><br>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<br>(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<u>, 54</u> | ~~54~~ | ☒~~☐~~ Create First Revision<br><br>☐ 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

| <u>**Compliance Required**</u> | <u>**Remote Locations**</u> | <u>**Locations Near Exposures**</u> | <u>**Reference**</u> |
|---|---|---|---|
| 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 |
|---|---|---|---|

| | | | |
|---|---|---|---|
| A.9.6.5.1 | 38 | | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | A.9.6.5.1<br>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.<br>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<br>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.<br>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. | | |
| 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 9.6.5.1.2.2 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 39 | | ~~☐~~☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.1.2 **Abnormal Conditions.**<br>Protection against the release of flammable gases during abnormal charging or thermal runaway conditions shall be in accordance with 9.6.5.6.<br>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) | 9.6.5.1.2.2 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) | 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) | |
|---|---|

| 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<br>☐ Resolve |

| Proposed Text (PI) | 9.6.7* Abnormal Toxic and highly toxic emission detection<br><br>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.<br><br>A.9.6.7<br><br>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. |
|---|---|

<table>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.6.7* Abnormal Toxic and highly toxic emission detection<br><br>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.<br><br>A.9.6.7<br><br>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.</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 9.6.7.1</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>41</td><td>None</td><td>☐☒ Create First Revision<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.7.1<br><br>Protection against the release of toxic and highly toxic gas emission during normal operation shall be in accordance with 4.6.11.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">9.6.7.1<br><br>Protection against the release of toxic and highly toxic gas emission during normal operation shall be in accordance with 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</td><td colspan="3"></td></tr>
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<table>
<tr><td>not making some changes or for resolving)</td><td colspan="3"></td></tr>
<tr><td rowspan="2">New 9.6.7.2</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>42</td><td>None</td><td>☐☒ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.7.2 *<br><br>Where toxic gas detection is used to provide evacuation notice and/or first responder alert, the detection system shall comply with the following:<br><br>1. The gas detection system shall be designed to provide a warning when the sensed gas(es) reaches the TWA REL.<br>2. The gas detection system shall provide an audible alarm when the sensed gas(es) reaches 25 percent of the IDLH.<br>3. The gas detection system shall be provided with a minimum of 2 hours of standby power.<br>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.<br>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:<br>a. A trouble signal upon failure of the gas detection system<br>b. An alarm signal if the sensed toxic gas(es) concentration exceeds the TWA REL<br><br>A.9.6.7.2<br><br>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.</td></tr>
</table>

**First Revision Text (FR)**

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.

**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.

Power requirements are added as new Section 4.10 to cover all EPSS requirements.

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

**New 9.6.7.3**

| All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|
| 43 | None | ☒ Create First Revision<br>☐ Resolve |

**Proposed Text (PI)**

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

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| | A.9.6.7.3<br><br>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*<br><br>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.<br><br>A.9.6.7.3<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.7.4*<br><br>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.<br><br>A.9.6.7.4<br><br>About Plume Models:<br><br>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.<br><br>Plume Modeling Methodology:<br><br>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.<br><br>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.<br><br>Source Term: | | |

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| | 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.<br><br>Weather Conditions<br><br>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.<br><br>Plume Model Outputs:<br><br>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.<br><br>First responder use of plume studies:<br><br>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.<br><br>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.<br><br>Minimum Approach Distance<br><br>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*<br><br>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.<br><br>A.9.6.7.4<br><br>About Plume Models:<br><br>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. |

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| | Plume Modeling Methodology:<br><br>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.<br><br>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.<br><br>Source Term:<br><br>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.<br><br>Weather Conditions<br><br>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.<br><br>Plume Model Outputs:<br><br>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.<br><br>First responder use of plume studies:<br><br>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.<br><br>Monitoring<br><br>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.<br><br>Minimum Approach Distance<br><br>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. |

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|---|---|---|---|
| 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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.7.5<br>A plume study shall not be required for outdoor remote locations. | | |
| First Revision Text (FR) | 9.6.7.5<br>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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.7.6<br>Toxic and highly toxic emission detection shall not be required for the following:<br>(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<br>(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<br>(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<br>(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973<br>(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 | | |

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| First Revision Text (FR) | 9.6.7.6<br><br>Toxic and highly toxic emission detection shall not be required for the following:<br><br>(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<br><br>(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<br><br>(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<br><br>(4) Lead-acid and Ni-Cd batteries listed in accordance with UL 1973<br><br>(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<br><br>☒ Resolve |
| Proposed Text (PI) | 15.10 ESS Toxic ~~and Highly Toxic~~ Gas Release During Normal Use.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.10 ESS Toxic and Highly Toxic Gas ~~Release~~ Emissions During Normal Use.<br><br>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.<br><br>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~~State 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 listings 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~~ESS 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<br>☐ 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

| 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]) |
| 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<br>☐ 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<br>☐ 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<br>☐ 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<br>☒ Resolve |
| Proposed Text (PI) | 4.7.1.1<br><br>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<br>☒ Resolve |

| | |
|---|---|
| Proposed Text (PI) | 4.7.1.1<br><br>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. |
| 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 was confusing to the task group as NFPA 76 was previously indicated as the standard and now it is recommended for deletion. |
| 4.7.1.1 | **All PIs used for FR or Resolve:** 357<br>**Other PIs that propose revisions for this section:** 113, 192<br>**MOTION:** ☐ Create First Revision<br>☒ Resolve |
| Proposed Text (PI) | 4.7.1.1<br><br>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. |
| 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) | Additional details should be submitted to justify the exception for zin magane~~s~~se in this area. |
| First Revision Text (FR) | 4.7.1.1<br><br>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. |

| 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<br><br>☒ Resolve |
| Proposed Text (PI) | 4.7.1.2<br><br>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<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 4.7.7.3<br><br>The requirements in 4.7.7 shall not apply to the following:<br><br>(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<br><br>(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<br><br>(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<br><br>(4) Lead-acid and Ni-cadmium battery systems listed to UL 1973. | | |

| | | | |
|---|---|---|---|
| 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 | | |
| 4.7.7.3 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 161 | 141 (different wording), 360 | ☐ Create First Revision<br>☐ 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 nickel-cadmium battery systems, which the batteries are listed to UL1973.

| | | | |
|---|---|---|---|
| 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) | | | |
| 4.7.7.3 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 360 | 141, 161 | ☐ Create First Revision<br>☒☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | 4.7.7.3<br><br>The requirements in 4.7.7 shall not apply to the following:<br><br>(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<br><br>(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<br><br>(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<br><br>The requirements in 4.7.7 shall not apply to the following:<br><br>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<br><br>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<br><br>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<br>☐ 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<br>☐ 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<br>☐ 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<br>☐ 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<br>Hybrid supercapacitors | 20<br>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).<br><br>[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.<br><br>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.<br><br>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<br><br>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<br>☐ 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<br>☐ 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<br>☐ 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<br>☐ 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.~~

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| 15.5 | 342 | 106, 343, 154, 117, 155, 118 | ☐ Create First Revision<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 15.5 Energy Ratings.<br><br>15.5.1<br><br>Individual ESS units shall have a maximum ~~stored energy~~ rating of 20 kWh.<br><br>15.5.2<br><br>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:~~<br><br>~~(1) 40 kWh within utility closets, basements, and storage or utility spaces~~<br><br>~~(2) 80 kWh in attached or detached garages and detached accessory structures~~<br><br>~~(3) 80 kWh where outdoor wall mounted~~<br><br>~~(4) 80 kWh where outdoor ground mounted~~<br><br>15.5.3<br><br>The total aggregate ratings of ESS on the property shall not exceed 600 kWh.<br><br>15.5.~~3~~4<br><br>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.<br><br>15.5.~~4*~~ 5 The use of an electric-powered vehicle to power the dwelling while parked shall comply with Section 15.11. | | |
| 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) | Where is attachment, need the table? (need tables to match). Task group 5 put in a 50kwh rating for fire barriers (coordination needed) | | |
| 15.5.1 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |

| | | | |
|---|---|---|---|
| | 106 | 342, 343 | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 15.5.1<br><br>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<br><br>☒ ☐ Resolve |
| Proposed Text (PI) | 15.5.1<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.5.1.1<br>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. | | |

<table>
<tr><td>Statement<br>(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response<br>(technical reason for not making some changes or for resolving)</td><td colspan="3">Tie into first revision, a bit more then 106….. tie in to that (take technologies in 106 listed into this subsection</td></tr>
<tr><td rowspan="2">15.5.2</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>117</td><td>342, 155</td><td>☐ Create First Revision<br><br>☒☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">15.5.2<br><br>The aggregate rating of the ESS shall not exceed the following for each location listed:<br><br>(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<br><br>(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<br><br>~~(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<br><br>(43) 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<br><br>(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</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revised text.</td></tr>
<tr><td>Statement<br>(technical reason for FR)</td><td colspan="3"></td></tr>
<tr><td>Response<br>(technical reason for not making some changes or for resolving)</td><td colspan="3">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)</td></tr>
<tr><td rowspan="2">15.5.2</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>155</td><td>342, 117</td><td>☒☐ Create First Revision<br><br>☐ Resolve</td></tr>
</table>

| | | | |
|---|---|---|---|
| Proposed Text (PI) | 15.5.2<br><br>The aggregate rating of the ESS shall not exceed the following for each location listed:<br><br>(1) 40 kWh within utility closets, basements, and storage or utility spaces<br>(2) 80 kWh in attached or detached garages and detached accessory structures<br>(3) 80 kWh where outdoor wall mounted<br>(4) 80 kWh where outdoor ground mounted.<br>(5) 250 kWh for lead-acid and nickel cadmium installations regardless of placements. | | |
| First Revision Text (FR) | See below for revised text. | | |
| Statement (technical reason for FR) | 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 | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| 15.5.3 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 118 | 342 | ☐ Create First Revision<br><br>☒ ~~☐~~ Resolve |
| Proposed Text (PI) | 15.5.3<br><br>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. | | |
| 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 evaluated pi 118 and felt this was duplicative text to the cyapter as a whole and could layer in confusion by the user. | | |
| First Revision Text (FR) | 15.5 Energy Ratings.<br><br>15.5.1 | | |

| | |
|---|---|
| | Individual ESS units shall have a maximum stored energy of 20 kWh.<br><br>15.5.1.1<br><br>Unit sizing for lead-acid and nickel-cadmium batteries listed to UL 1973 shall not be restricted.<br><br>15.5.2<br><br>The aggregate rating of the ESS shall not exceed the following for each location listed:<br><br>1. 40 kWh within utility closets, basements, and storage or utility spaces<br>2. 80 kWh in attached or detached garages and detached accessory structures<br>3. 80 kWh where outdoor wall mounted<br>4. 80 kWh where outdoor ground mounted<br>~~4.~~5. (5) 250 kWh for lead-acid and nickel cadmium installations regardless of placements.<br><br>15.5.3<br><br>ESS installations exceeding the individual or aggregate ratings allowed by 15.5.1 or 15.5.2 shall comply with Chapters 4 through 9.<br><br>15.5.4*<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | B.3.2 Chemical Hazards.<br><br>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.<br><br>Examples of chemical hazards are as follows:<br><br>(1) *Liquid hazards*:<br><br>(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, | | |

<table>
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<td>
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.<br><br>
(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.<br><br>
(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.<br>
(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.<br><br>
(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.
</td>
</tr>
<tr>
<td>First Revision Text (FR)</td>
<td>
B.3.2 Chemical Hazards.<br><br>
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:<br><br>
1. *Liquid hazards*:<br>
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.<br>
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.
</td>
</tr>
</table>

| | |
|---|---|
| | 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.<br><br>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.<br><br>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<br>(technical reason for FR) | Came from task group 20, on flow batteries, grab committee statement<br>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<br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | B.5.1.3 Zinc Air Flow Batteries.<br><br>Hazard considerations for zinc air flow batteries under normal operating conditions are as follows:<br><br>(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.<br><br>(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.<br><br>(4) *Stranded or stored energy hazards*: Not applicable.<br><br>(5) *Physical hazards*: Not applicable.<br><br>Hazard considerations for zinc air flow batteries under emergency/abnormal conditions are as follows:<br><br>(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.~~<br><br>(2) *Chemical hazards*: There are large amounts of corrosives that can create a hazard if the containment fails.<br><br>(3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br><br>(4) *Stranded or stored energy hazards*: Not applicable.<br><br>(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.<br><br>Hazard considerations for zinc air flow batteries under normal operating conditions are as follows:<br><br>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.<br><br>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.<br><br>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.<br><br>4. *Stranded or stored energy hazards*: Not applicable. |

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| | 5. *Physical hazards*: Not applicable.<br><br>Hazard considerations for zinc air flow batteries under emergency/abnormal conditions are as follows:<br><br>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.~~<br><br>2. *Chemical hazards*: There are large amounts of corrosives that can create a hazard if the containment fails.<br><br>3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br><br>4. *Stranded or stored energy hazards*: Not applicable.<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | **B.5.4** Lithium Metal, Solid State Batteries — General Description.<br>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 | | |

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| | 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.<br><br>Hazard considerations for lithium metal batteries under normal operating conditions are as follows:<br><br>(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.<br>(2) *Chemical hazards*: Not applicable.<br>(3) *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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.<br>(5) *Physical hazards*: Not applicable.<br><br>Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows:<br><br>(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.<br>(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.<br>(3) *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(5) *Physical hazards*: Depending on the design of the system, the potential exists for physical<br><br>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.<br>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.<br><br>Hazard considerations for lithium metal batteries under normal operating conditions are as follows:<br><br>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.<br>2. *Chemical hazards*: Not applicable. |

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| | 3. *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>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.<br>5. *Physical hazards*: Not applicable.<br><br>Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows:<br><br>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.<br>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.<br>3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>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.<br>5. *Physical hazards*: Depending on the design of the system, the potential exists for physical<br>6. overheating or if there is us parts such as fans where guards might be missing.<br><br>B.5.4 Lithium Metal, Solid State Batteries — General Description.<br><br>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.<br><br>1. Hazard considerations for lithium metal batteries under normal operating conditions are as follows:<br>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.<br>3. *Chemical hazards*: Not applicable. |

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| | 4. *Electrical hazards*: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br><br>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.<br><br>6. *Physical hazards*: Not applicable.<br><br>Hazard considerations for lithium metal batteries under emergency/abnormal conditions are as follows:<br><br>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.<br><br>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.<br><br>3. *Electrical hazards*: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br><br>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.<br><br>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<br>☐ Resolve |
|---|---|---|---|
| Proposed Text (PI) | B.5.8 Nickel Hydrogen<br><br>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.<br><br>Hazard considerations for Nickel Hydrogen batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable.<br>(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for nickel hydrogen under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: None indicated<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(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<br><br>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.<br><br>Hazard considerations for Nickel Hydrogen batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable.<br>(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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. | | |

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| | (5) Physical hazards: Not applicable.<br><br>Hazard considerations for nickel hydrogen under emergency or abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: None indicated<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>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) | |



| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| New B.5.8 | 236 | None | ☒ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | B.5.8 Zinc-Manganese Battery systems<br><br>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.<br><br>Hazard considerations for Zinc-Manganese batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable.<br>(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels. | | | |

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| | (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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Zinc-Manganese batteries under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards:<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(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<br><br>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.<br><br>Hazard considerations for Zinc-Manganese batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable.<br>(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Zinc-Manganese batteries under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards:<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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. |

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| | (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<br>☐ Resolve |
| Proposed Text (PI) | B.5.8 Zinc-Bromide<br><br>Zinc-Bromide, non flow batteries<br>Hazard considerations for Zinc-Bromide batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable.<br>(3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Zinc-Bromide batteries under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards:<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(5) Physical hazards: Contact with internal components may cause irritation or burns. | | |
| First Revision Text (FR) | B.5.8 Zinc-Bromide<br><br>Zinc-Bromide, non flow batteries<br>Hazard considerations for Zinc-Bromide batteries under normal operating conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards: Not applicable. | | |

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| | (3) Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Zinc-Bromide batteries under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards: Thermal runaway not noted during testing<br>(2) Chemical hazards:<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | B.5.8 Metal Air Batteries - General Description<br><br>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 | | |

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| | 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.<br><br>B.5.8.1 Iron-Air Batteries. Hazard considerations for iron-air batteries under normal operating conditions are as follows:<br><br>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.~~<br>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.<br>3. Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>4. Stranded or stored energy hazards: Not applicable.<br>5. Physical hazards: Not applicable.<br><br>Hazard considerations for iron-air batteries under emergency/abnormal conditions are as follows:<br><br>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.<br>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.<br>3. Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>4. Stranded or stored energy hazards: Not applicable.<br>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<br><br>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.<br><br>B.5.8.1 Iron-Air Batteries. Hazard considerations for iron-air batteries under normal operating conditions are as follows: |

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| | 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.<br>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.<br>3. Electrical hazards: There are electrical hazards associated with routine maintenance of these batteries if they are at hazardous voltage and energy levels.<br>4. Stranded or stored energy hazards: Not applicable.<br>5. Physical hazards: Not applicable.<br><br>Hazard considerations for iron-air batteries under emergency/abnormal conditions are as follows:<br><br>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.<br>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.<br>3. Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>4. Stranded or stored energy hazards: Not applicable.<br>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<br><br>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<br>☐ Resolve |

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| Proposed Text (PI) | B.6.2 Hybrid Super capacitors<br>Hazard considerations for Hybrid Super capacitors under normal operating conditions are as follows:<br><br>(1) Fire hazards:<br>(2) Chemical hazards: Not applicable.<br>(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.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Hybrid Super capacitors under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards:<br>(2) Chemical hazards:<br>(3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(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<br>Hazard considerations for Hybrid Super capacitors under normal operating conditions are as follows:<br><br>(1) Fire hazards:<br>(2) Chemical hazards: Not applicable.<br>(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.<br>(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.<br>(5) Physical hazards: Not applicable.<br><br>Hazard considerations for Hybrid Super capacitors under emergency/abnormal conditions are as follows:<br><br>(1) Fire hazards:<br>(2) Chemical hazards: |

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| | (3) Electrical hazards: Electrical hazards might be present under abnormal conditions if the system is at hazardous voltage and energy levels.<br>(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.<br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | Fire Command Center<br><br>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.<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 4.7.1 Mixing of ESS Technologies.<br><br>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. | | |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | 4.8 Smoke and Fire Detection.<br><br>4.8.2 Annunciation.<br><br>4.8.2.1<br><br>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]<br><br>4.8.2.2*<br><br>Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ.<br><br>A.4.8.2.2<br><br>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*<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 4.8.1 | | |

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| | 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. |
| First Revision Text (FR) | 4.8.1*<br><br>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. |
| Statement (technical reason for FR) | 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. |
| Response (technical reason for not making some changes or for resolving) | |

| A.4.8.1 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 11, 317 (same revision) | | ☒ Create First Revision<br><br>☐ Resolve |

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| Proposed Text (PI) | A.4.8.1<br><br>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.<br><br>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.<br><br>Gas detection technology can also provide additional information on conditions inside the ESS enclosure. |
| First Revision Text (FR) | A.4.8.1<br><br>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 |

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<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.<br><br>~~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.~~<br><br>~~Gas detection technology can also provide additional information on conditions inside the ESS enclosure.~~</td></tr>
<tr><td>Statement<br>(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<br>(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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">9.6.1.1 *<br><br>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.<br><br>A. 9.6.1.1<br><br>Paragraph 4.8.1.1 aligns with 90.2(B)(4) of NFPA 70.<br><br>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.<br><br>See NFPA 76 for more information on fire detection for telecommunications structures.</td></tr>
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| First Revision Text (FR) | ~~4.8~~ 9.6.1.1 *<br><br>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.<br><br>A. ~~4.8~~ 9.6.1.1<br><br>Paragraph ~~4.8~~9.6.1.1 aligns with 90.2(B)(4) of NFPA 70.<br><br>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.<br><br>See NFPA 76 for more information on fire detection for telecommunications structures. |
| 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) | |
| Response (technical reason for not making some changes or for resolving) | |

| 4.8.1.2 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 274 | 259 | ☒ Create First Revision<br><br>☐ Resolve |

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| Proposed Text (PI) | 9.6.1.2*<br><br>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.<br><br>A. 9.6.1.2<br><br>Paragraph 4.8.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70. |

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<tr><td>First Revision Text (FR)</td><td colspan="3">~~4.8~~9.6.1.2*<br><br>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.<br><br>A.~~4.8~~ 9.6.1.2<br><br>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<br><br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">A.4.8.2.2<br><br>- 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<br><br>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.<br><br>~~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>
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| | ~~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<br><br>☐ Resolve |
| Proposed Text (PI) | ~~4.8.3~~ 9.6.1.5*<br><br>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.<br><br>A.~~4.8.3~~ 9.6.1.5<br><br>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*<br><br>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.<br><br>A.~~4.8.3~~ 9.6.1.5<br><br>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<br>☐ 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.~~<br>~~A.4.9.1.1~~<br>~~Paragraph 4.9.1.1 aligns with 90.2(B)(4) of NFPA 70.~~<br>~~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.~~<br>~~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.~~<br>~~A.4.9.1.3~~<br>~~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<br>☒ Resolve |

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|---|---|---|---|
| Proposed Text (PI) | 4.9.1.1*<br><br>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. | | |
| 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. | | |
| ~~4.9.1.2~~ | ~~All PIs used for FR or Resolve~~ | ~~Other PIs that propose revisions for this section~~ | ~~MOTION~~ |
| | ~~362, 361, 363~~ | | ~~☐ Create First Revision~~<br><br>~~☒ Resolve~~ |
| Proposed Text (PI) | 4.9.1.2<br><br>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. | | |
| 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. | | |
| ~~4.9.1.3~~ | ~~All PIs used for FR or Resolve~~ | ~~Other PIs that propose revisions for this section~~ | ~~MOTION~~ |
| | ~~363, 361, 362~~ | | ~~☐ Create First Revision~~<br><br>~~☒ Resolve~~ |

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| Proposed Text (PI) | 4.9.1.3*<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 4.9.3 Alternate Automatic Fire Control, Suppression and Thermal Runaway Mitigation Systems.<br><br>4.9.3.1*<br><br>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.<br><br>4.9.3.2*<br><br>The automatic fire control, suppression, and thermal runaway mitigation systems shall comply with the following standards, or their equivalent, as appropriate:<br><br>(1) NFPA 12<br>(2) NFPA 15<br>(3) NFPA 750<br>(4) NFPA 770<br>(5) NFPA 2001<br>(6) NFPA 2010<br>(7) UL 9540 | | |
| First Revision Text (FR) | | | |

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| Statement (technical reason for FR) | | | |
| Response (technical reason for not making some changes or for resolving) | 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. | | |
| 4.9.3.2 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 326 | ~~220~~ | ☐ Create First Revision<br>☒ Resolve |
| Proposed Text (PI) | 4.9.3.2*<br>The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:<br>(1) NFPA 12<br>(2) NFPA 15<br>(3) NFPA 18A<br>(4) NFPA 750<br>(5) NFPA 770<br>(6) NFPA 2001<br>(7) NFPA 2010 | | |
| Response (technical reason for not making some changes or for resolving) | Insufficient information provided that NFPA 18A is sufficient for acceptability of the system. | | |
| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| 4.9.3 | | | ☒~~☐~~ Create First Revision<br>☐ Resolve |
| First Revision Text (FR) | 4.9.3.2*<br>The automatic fire control and suppression systems shall comply with the following standards, or their equivalent, as appropriate:<br>~~(1) NFPA 12~~<br>(1~~2~~) NFPA 15<br>(2~~4~~) NFPA 750<br>~~(5) NFPA 770~~ | | |

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| | ~~(6) NFPA 2001~~<br><br>~~(7) NFPA 2010~~<br><br>A.4.9.3.2<br><br>~~Gaseous Agents. Gaseous agent fire suppression systems can be used to protect ESS fires in either of the following two ways:~~<br><br>~~(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.~~<br><br>~~(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.~~<br><br>~~See G.6.1.4 for more information on the use of gaseous/clean agent fire suppression with LIB-based ESS.~~<br><br>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.<br><br>See G.6.1.3 for more information on the use of water mist systems with LIB-based ESS. |
| Statement<br>(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<br>(technical reason for not making some | |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.1 Smoke and Fire Detection.<br><br>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.<br><br>9.6.1.1 *<br><br>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.<br><br>A.9.6.1.1<br><br>Paragraph 9.6.1.1 aligns with 90.2(B)(4) of NFPA 70.<br><br>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.<br><br>See NFPA 76 for more information on fire detection for telecommunications structures.<br><br>9.6.1.2 *<br><br>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.<br><br>A.9.6.1.2<br><br>Paragraph 4.8.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70. | | |

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| | 9.6.1.3<br><br>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]<br><br>9.6.1.4 *<br><br>Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ.<br><br>A.9.6.1.4<br><br>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.<br><br>9.6.1.5 *<br><br>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.<br><br>A.9.6.1.5<br><br>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.<br><br>9.6.1.6<br><br>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.<br><br>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.<br><br>~~4.8~~ 9.6.1.1 *<br><br>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.<br><br>A. ~~4.8~~ 9.6.1.1<br><br>~~Paragraph~~ Section ~~4.8~~9.6.1.1 aligns with 90.2(B)(4) of NFPA 70.<br><br>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 |

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| | 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.<br><br>See NFPA 76 for more information on fire detection for telecommunications structures.<br><br>~~4.8~~9.6.1.2*<br><br>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.<br><br>A.9.6.1.2<br><br>~~Paragraph~~ Section ~~4.8~~9.6.1.2 aligns with the scope of 90.2(D)(5) of NFPA 70.<br><br>9.6.1.3<br><br>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]<br><br>9.6.1.4 *<br><br>Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or location approved by the AHJ.<br><br>A.9.6.1.4<br><br>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.<br><br>~~4.8.3~~ 9.6.1.5*<br><br>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.<br><br>A.~~4.8.3~~ 9.6.1.5<br><br>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.<br><br>9.6.1.6<br><br>Alarm signals from detection systems shall be transmitted to a supervising station in accordance with NFPA 72. |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.2.1<br><br>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<br><br>~~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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.2.2.4<br><br>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 | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.2.4<br><br>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<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.3*<br><br>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.<br><br>A.9.6.3<br><br>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**<br><br>**9.6.3.1 Basic Testing.**<br><br>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.<br><br>**9.6.3.1.1**<br><br>When a fire protection or life safety system is tested, the response of integrated fire protection and life safety systems shall be verified.<br><br>**9.6.3.1.2**<br><br>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.<br><br>**9.6.3.2 NFPA 4 Testing.**<br><br>**9.6.3.2.1**<br><br>For new buildings, integrated testing in accordance with NFPA 4 shall be conducted prior to the issuance of a certificate of occupancy.<br><br>**9.6.3.2.2**<br><br>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. | | |

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| | **9.6.3.3 NFPA 3 Commissioning.**<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 9.6.3.1<br><br>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<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 9.6.4.1*<br><br>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 | | |

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| | 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.<br><br>A.9.6.4.1<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 4.3.1* General.<br>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.<br>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<br>☐ Resolve |
| Proposed Text (PI) | 4.3.2<br>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.<br>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. | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 4.3.2.1.2<br>~~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<br>~~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<br>☒ Resolve |
| Proposed Text (PI) | 4.3.2.1.4<br>The emergency operations plan shall include the following:<br>(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<br>(2) Procedures for inspection and testing of associated alarms, interlocks, and controls<br>(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 | | |

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| | equipment, summoning service or repair personnel, and providing agreed-upon notification to fire department personnel, if required<br><br>(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<br><br>(5) Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required<br><br>(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<br><br>(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders<br><br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | 4.3.2.1.4<br><br>The emergency operations plan shall include the following:<br><br>(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~~<br><br>(2) Procedures for inspection and testing of associated alarms, interlocks, and controls<br><br>(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<br><br>(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<br><br>(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></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<br><br>(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders<br><br>(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<br><br>The emergency operations plan shall include the following:<br><br>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~~<br>2. Procedures for inspection and testing of associated alarms, interlocks, and controls<br>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<br>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<br>5. Response considerations similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment when an SDS is not required<br>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<br>7. Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders<br>8. Procedures and schedules for conducting drills of these procedures</td></tr>
<tr><td>Statement<br>(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<br>(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<br><br>☒~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.3.2.1.4<br><br>The emergency operations plan shall include the following:</td></tr>
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| | |
|---|---|
| | (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<br>(2) Procedures for inspection and testing of associated alarms, interlocks, and controls<br>(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<br>(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<br>(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<br>(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<br>(7) Other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders<br>(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<br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 4.3.2.1.5<br>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. | | |

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| 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<br>☒ Resolve |
| Proposed Text (PI) | 4.3.2.1.5<br>~~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<br>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<br>☒ Resolve |
| Proposed Text (PI) | 4.3.2.1.6<br>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 | | |

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| | communications utilities used in stationary standby service and located outdoors or in building spaces used exclusively for such installations that comply with NFPAP 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<br><br>☐ Resolve |

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| Proposed Text (PI) | 4.3.2.2.1<br><br>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.<br><br>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<br><br>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.<br><br>4.3.2.2.2.<br><br>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. |

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| Response<br>(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 4.3.3 | 158 | None | ☐ Create First Revision<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 4.3.3 Emergency Response Plan<br><br>4.3.3.1<br><br>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.<br><br>4.3.3.2 Emergency Response Plan <u>Details</u><br><br>4.3.3.2.1<br>The emergency response plan shall be in accordance with Chapters 17 through 23 of NFPA 1660.<br><br>4.3.3.2.2<br>The emergency response plan shall, at a minimum, address the following:<br>1. Mitigation<br>2. Preparedness<br>3. Response<br>4. Recovery<br><br>4.3.3.3 Training<br><br>4.3.3.3.1<br><br>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.<br><br>4.3.3.3.2<br>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.<br><br>4.3.3.4 Refresher Training<br><br>4.3.3.4.1 | | |

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| | Refresher training shall be conducted by ESS facility operations personnel at least annually.<br><br>4.3.3.4.2.<br><br>Records of such training shall be retained in an approved manner.<br><br>4.3.3.5 Notification<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 7.1.1 Electric Utilities Under NERC Jurisdiction.<br><br>7.1.1.1<br><br>Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements.<br><br>7.1.1.2<br>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 | | |

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| | exclusive control of the electric utility and located outdoors or in building spaces used exclusively for such installations.<br><br>7.1.2<br><br>The operation and maintenance documentation shall include the following:<br><br>(1) Procedures for the ~~safe~~ startup of the ESS system and associated equipment<br>(2) Procedures for inspection and testing of associated alarms, interlocks, and controls<br>(3) Procedures for maintenance and operation of the following, where applicable:<br>(a) Energy storage management systems (ESMS)<br>(b) Fire protection equipment and systems<br>(c) Spill control and neutralization systems<br>(d) Exhaust and ventilation equipment and systems<br>(e) Gas detection systems<br>(f) Other required safety equipment and systems<br>(4) Response considerations similar to a safety data sheet (SDS) that address response safety concerns and extinguishment where an SDS is not required<br><br>(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.<br><br>7.1.1.1<br><br>Electric utilities under NERC jurisdiction shall comply with NERC PRC-005 requirements.<br><br>7.1.1.2<br><br>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.<br><br>7.1.2<br><br>The operation and maintenance documentation shall include the following:<br><br>1. Procedures for the ~~safe~~ startup and shutdown of the ESS system and associated equipment<br><br>2. Procedures for inspection and testing of associated alarms, interlocks, and controls |

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<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.<br><br>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<br><br>☒ 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

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| | (c) Spill control and neutralization systems<br>(d) Exhaust and ventilation equipment and systems<br>(e) Gas detection systems<br>(f) Other required safety equipment and systems<br>(4) Response considerations similar to a safety data sheet (SDS) that address response safety concerns and extinguishment where an SDS is not requiredEmergency response plan shall be prepared according to *4.3 Emergency Planning and Training*<br>(5) *An instruction that equipment or system changes to the installation are required to be recorded by updating any engineering documentation<br>7.1.3 SDS for Hazardous Materials.<br>7.1.3.1<br>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.<br>7.1.3.2<br>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. |

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| --- | --- | --- | --- |
| New A.4.6.3.1 | 90 | None | ☐ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | A.4.6.3.1<br><br>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 | | |
| First Revision Text (FR) | 4.6.3.1<br><br>Retrofits of ESS shall be approved and comply with the following unless modified in other sections:<br><br>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.<br>2. ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer's instructions.<br>3. The overall installation shall continue to comply with UL 9540 listing requirements, where applicable.<br>4. Retrofits shall be documented in the maintenance, testing, and events log required in 4.2.3. | | |
| 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 4.6.5.1 | 334 | None | ☐ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 4.6.5.1<br><br>Repurposed, remanufactured, and refurbished batteries shall also comply with 9.2.4. | | |
| First Revision Text (FR) | To create a FR, revise text above or paste final version here. | | |

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| 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<br>☐ Resolve |

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| Proposed Text (PI) | 6.4.4*<br><br>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<br>☐ Resolve |

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|---|---|
| Proposed Text (PI) | A.6.4.4<br><br>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. |

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| 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*<br><br>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.<br><br>A.6.4.4<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.2.4 Repurposed, Remanufactured, and Refurbished Batteries.<br><br>**9.2.4.1***<br><br>This section covers batteries that have been repurposed, remanufactured, or refurbished. This includes batteries previously used in other applications, such as electric vehicle propulsion.<br><br>**A.9.2.4.1**<br><br>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.

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| | A.9.2.4.6<br><br>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.<br><br>**9.2.4.1***<br><br>This section shall apply to batteries that have been repurposed, remanufactured, or refurbished.<br><br>**A.9.2.4.1**<br><br>This section covers repurposed, remanufactured, and refurbished batteries used in ESS. This includes batteries previously used in other applications, such as electric vehicle propulsion.<br><br>“Repurposed” most often refers to batteries and battery modules previously used in electric vehicles.<br><br>“Remanufactured” refers to rebuilt or refurbished batteries that have undergone a manufacturing type process to allow them to be used in an ESS application.<br><br>“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.<br><br>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.<br><br>The requirements in this section do not cover normal maintenance and testing operations on batteries conducted in accordance with the original battery OEMs instructions.<br><br>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.<br><br>**9.2.4.2**<br><br>ESS containing repurposed, remanufactured, or refurbished batteries shall comply with all applicable requirements in this standard for ESS containing new batteries.<br><br>9.2.4.3<br><br>Batteries that have been repurposed, remanufactured, or refurbished shall meet the applicable technology-specific requirements in Table 9.6.5.<br><br>9.2.4.4 |

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| | Refurbished batteries that are used in an application that differs from the original use, or have internal parts replaced or repaired shall:<br><br>1) comply with 9.2.4 for remanufactured batteries<br>2) comply with 4.2.4.5 and 4.2.4.6.<br><br>9.2.4.5*<br><br>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.<br><br>A.9.2.4.5<br><br>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.<br><br>9.2.4.6*<br><br>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.<br><br>A.9.2.4.6<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 1.3.1*<br><br>ESS shall comply with the requirements of this standard, as applicable.<br><br>~~A.1.3.1~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 1.3.5*<br><br>This standard does not apply to product research, development, and testing conducted at laboratory occupancies and pilot plants.<br><br>A.1.3.5<br><br>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*<br><br>Where approved by the AHJ, alternate safety measure shall be permitted to be applied for purpose of research, development, or testing.<br><br>A.1.3.5 | | |

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| | 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<br><br>☒ Resolve |
| Proposed Text (PI) | 15.4.1<br><br>ESS shall only be installed in the following locations:<br><br>(1) In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code<br><br>(2) In detached garages and detached accessory structures<br><br>(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~~.<br><br>(4) In enclosed utility closets and storage or utility spaces where approved by the AHJ | | |

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| First Revision Text (FR) | 15.4.1<br><br>ESS shall only be installed in the following locations:<br><br>1. In attached garages separated from the dwelling unit living area and sleeping units in accordance with the local building code<br>2. In detached garages and detached accessory structures<br>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<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 15.4.2<br><br>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<br><br>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 | | | |

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| changes or for resolving) | |

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| Move 15.11 to 4.11 | 127, 128 (annex) | ~~None~~126, 355 (TG5 for 4.11) | ☒~~☐~~ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | ~~15~~ 4.11* Electric Vehicle Battery Use.<br><br>Utilizing electric vehicles to export power to premise wiring shall follow the requirements in Section 4.11.<br><br>A.4.11 Electric Vehicle Battery Use.<br><br>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.<br><br>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.<br><br>~~15~~ 4.11.1<br><br>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.<br><br>~~15~~ 4.11.2<br><br>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. | | |
| First Revision Text (FR) | 4.11 * Vehicle to Grid (V2G) Usage.<br><br>A.4.11 Vehicle to Grid (V2G) Usage.<br><br>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. | | |

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| | 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.<br><br>4.11.1<br><br>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.<br><br>4.11.2<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 15.11 * Electric Vehicle Battery Residential Use.<br><br>A.15.11 Electric Vehicle Battery Residential Use<br><br>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,<br><br>15.11.1<br><br>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~~ | | |

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| | ~~detached garage or outside~~ shall comply with the vehicle manufacturer's instructions and NFPA 70.<br><br>15.11.2<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | A.1.4.2<br><br>~~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.<br><br>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*<br><br>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.<br><br>A.1.4.2<br>~~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.<br><br>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<br><br>☐ Resolve |

<table>
<tr><td>Proposed Text (PI)</td><td colspan="3">4.4.1*<br><br>A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:<br><br>(1) Technologies not specifically addressed in Table 1.3 are provided<br>(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible<br>(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2<br>(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements<br>(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1<br>(6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1<br>(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*<br><br>A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:<br><br>(1) Technologies not specifically addressed in Table 1.3 are provided<br>(2) More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible<br>(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2<br>(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements<br>(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1<br>(6) Where required for outdoor lithium-ion battery ESS systems in accordance with 9.5.2.1<br>(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<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 4.4.1*<br><br>A hazard mitigation analysis shall be provided to the AHJ for review and approval where any of the following conditions are present:<br><br>(1) Technologies not specifically addressed in Table 1.3 are provided<br><br>(2) ~~More than one ESS technology is provided in a single fire area where adverse interaction between the technologies is possible~~<br><br>(3) Where allowed as a basis for increasing maximum stored energy as specified in 9.4.1.1 and 9.4.1.2<br><br>(4) Where required by the AHJ to address a potential hazard with an ESS installation that is not addressed by existing requirements<br><br>(5) Where required for existing lithium-ion ESS systems that are not UL 9540 listed in accordance with 9.2.2.1<br><br>(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<br><br>☐ Resolve |
| Proposed Text (PI) | A.4.4.1<br><br>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:<br><br>(1) IEC 60812<br><br>(2) IEC 61025 | | |

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| | (3) MIL-STD-1629A<br><br>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.<br>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.<br><br>To clarification of "adverse" see Section 9.4.1.3 and Section 9.6.2.3. |
| First Revision Text (FR) | A.4.4.1<br><br>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:<br><br>(1) IEC 60812<br>(2) IEC 61025<br>(3) MIL-STD-1629A<br><br>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.<br><br>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.<br><br>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. |

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|---|---|
| | 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. |

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

| **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.

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| | **16.4.2**<br><br>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.<br><br>**16.5 Fire Control and Suppression**<br><br>Fire suppression agents used in rooms or areas that contain flow batteries shall be compatible with the flow battery materials and electrolytes.<br><br>**16.6 Spill Control**<br><br>**16.6.1**<br><br>Where spill control is provided as part of the installation an alarm system shall be provided to signal an electrolyte leak from the system.<br><br>**16.6.2**<br><br>Where required, alarm signals shall be transmitted to an approved location.<br><br>**16.7 Hazard Support Personnel.**<br><br>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<br><br>A 6.1.3.2 | 91, 92 | | ☒ Create First Revision<br><br>☐ Resolve |

| | |
|---|---|
| Proposed Text (PI) | |
| First Revision Text (FR) | 6.1.3.2*<br><br>The commissioning plan shall include, but not be limited to, the following information:<br><br>(1) An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted<br>(2) Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s)<br>(3) Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s)<br>(4) Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems<br>(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<br>(6) Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems<br>(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<br>(8) The following documentation:<br>(a) Commissioning checklist<br>(b) Relevant operational testing forms<br>(c) Necessary commissioning logs<br>(d) Progress reports<br>(13) Means and methods whereby facility operation and maintenance staff will be trained on the system<br>(14) Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system<br>(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<br><br>A.6.1.3.2<br><br>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:<br><br>(1) ESS input and output power should track the commands.<br>(2) ESS shuts down when shut-down command is sent.<br>(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. |

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| 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<br><br>A. 4.6.3.1 | 90 | | ☒ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 4.6.3.1*<br><br>Retrofits of ESS shall be approved and comply with the following unless modified in other sections:<br><br>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.<br>2. ESS management and other monitoring systems shall be connected and installed in accordance with the manufacturer's instructions.<br>3. The overall installation shall continue to comply with UL 9540 listing requirements, where applicable.<br><br>Retrofits shall be documented in the maintenance, testing, and events log required in 4.2.3.<br><br>A.4.6.3.1<br>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 | | | |

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|---|---|
| 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<br><br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 9.6.5.1.4*<br><br>Natural Exhaust Ventilation.<br>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~~ <u>conditions including</u> 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<br><br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 9.6.1.5<br><br>Exhaust ventilation shall be provided in accordance with the applicable mechanical code and one of the following:<br><br>(1) Where hydrogen is the gas generated, an exhaust ventilation rate based on hydrogen generation estimates sufficient to limit the maximum | | |

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| | 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<br><br>(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) | |

| Section | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| 13.1.3 | 198 | None | ☒ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | 13.1.3*<br>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. | | |
| First Revision Text (FR) | 13.1.3*<br>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:<br>1) It is designed by a registered design professional<br>2) It, is approved by the AHJ<br>1)3) It , and is maintained by a trained service provider when regular maintenance is required.<br>A.13.1.3<br>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. | | |
| Statement (technical reason for FR) | 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. | | |
| 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 |
|---|---|---|---|
| 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<br><br>See also 13.2.4 and 13.1.2 |
| Retrofits | ~~4.6.3~~ Yes | Except 4.6.3.2~~—N/A~~<br><br>and 4.6.3.3~~—N/A~~ (see 13.1.2) |
| Environments | ~~4.6.7~~Yes | 4.6.7<br><br>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<br><br>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<br><br>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<br><br>~~(~~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<br>~~(~~See 13.2.10~~)~~ |
| Fire Control and Suppression | ~~Section 4.9~~ No | ~~N/A~~ 4.9<br>~~(~~See 13.2.11~~)~~ |
| Explosion Control | ~~9.6.5.6~~ No | ~~N/A~~ 9.6.5.6<br>~~(~~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<br>See also Section 13.3 |
| Operation and Maintenance | ~~Chapter 7~~ Yes | 7<br>See also Section 13.4 |
| | -No | 7.1.3~~– N/A~~ |
| Decommissioning | ~~Chapter 8~~ Yes | 8<br>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<br>See also 13.2.4 and 13.1.2 |
| Retrofits | ~~4.6.3~~Yes | Except 4.6.3.2 ~~— N/A~~<br>and 4.6.3.3~~— N/A~~ *(see 13.1.2)* |
| Environment | ~~4.6.7~~Yes | 4.6.7<br>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<br>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<br>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<br>~~(~~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<br>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<br>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~~<br>*See 13.2.10*~~)~~ |
| Fire control and suppression | ~~Section 4.9~~No | 4.9~~N/A (s~~<br>See 13.2.11~~)~~ |

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| 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 | 5 |
| | No | ~~Section~~ 5.3~~ N/A~~ |
| Commissioning | ~~Chapter 6~~Yes | 6<br>See also Section 13.3 |
| Operation and maintenance | ~~Chapter 7~~Yes | 7<br>See also Section 13.4 |
| | No | 7.1.3~~ N/A~~ |
| Decommissioning | ~~Chapter 8~~Yes | 8<br>See also Section 13.5 |

~~N/A: Not applicable.~~

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 13.2.5*<br>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 | | | |

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|---|---|---|---|
| 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<br><br>☐ Resolve |
| Proposed Text (PI) | A.13.2.5<br><br>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. <u>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.</u> | | |
| 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*<br><br>FESS shall not be installed in <u>locations where high levels of ground vibration (not including seismic vibration) are transmitted to the operating flywheel and its bearings</u> <u>~~unless~~</u> <u>the following conditions are met:</u><br><br><u>1) Means are provided to limit the vibrations within acceptable limits for the FESS</u><br><br><u>2)</u> T<u>he installation is evaluated by a registered design professional.</u> ~~locations that could stress the bearing systems and impact their operation.~~<br><br>A.13.2.5<br><br>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. <u>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.</u> | | |

| 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<br>☒ Resolve |
| Proposed Text (PI) | 13.2.6*<br>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.~~<br>13.2.6.1<br>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.<br>13.2.6.2*<br>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<br>☐ Resolve |
| Proposed Text (PI) | ~~13.2.6*~~<br>~~The energy storage management system (ESMS) of a FESS shall include bearing monitoring for magnetic bearings.~~<br>~~13.2.6.1~~<br>~~There shall be some means (e.g., alarm, hazard light, warning signal to control panel) to annunciate when bearing changes are due.~~<br>~~13.2.6.2*~~<br>~~The ESMS shall monitor and record temperature and vibration of the FESS.~~ | | |

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| 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*~~<br><br>~~The energy storage management system (ESMS) of a FESS shall include bearing monitoring for magnetic bearings.~~<br><br>~~A.13.2.6~~<br><br>~~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.~~<br><br>~~13.2.6.1~~<br><br>~~There shall be some means (e.g., alarm, hazard light, warning signal to control panel) to annunciate when bearing changes are due.~~<br><br>~~13.2.6.2*~~<br><br>~~The ESMS shall monitor and record temperature and vibration of the FESS.~~<br><br>~~A.13.2.6.2~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 13.2.7.1<br><br>The seismic ratings of the FESS and suitability of ~~mounting means shall be~~ <u>the seismic mounting means shall be determined by a registered design professional prior to installation and</u> verified during installation. | | |

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| First Revision Text (FR) | 13.2.7.1<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | A.13.2.10<br><br>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*<br><br>Smoke and fire detection for FESS installations shall be in accordance with the local building code.<br><br>A.13.2.10<br><br>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 |
|---|---|---|---|

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|---|---|---|---|
| New A.13.2.11 | 208 | None | ☒☐ Create First Revision<br>☐ Resolve |
| Proposed Text (PI) | A.13.2.11<br>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*<br>Fire control and suppression for FESS installation shall be in accordance with the local building code.<br>A.13.2.11<br>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<br>☐ Resolve |
| Proposed Text (PI) | 13.2.12*<br>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 | | | |

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|---|---|---|---|
| changes or for resolving) | | | |
| A.13.2.12 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | 212 | 203 | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | A.13.2.12<br><br>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. | | |
| First Revision Text (FR) | See below for revised text. | | |
| Statement (technical reason for FR) | 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. | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| First Revision Text (FR) | 13.2.12*<br><br>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:<br><br>1) the flywheel design and its production quality controls mitigate the risk of sudden flywheel rupture or<br>~~1)~~2) ~~if~~ a rupture can be contained completely within the primary flywheel housing.<br><br>A.13.2.12 | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | 13.3* Commissioning.<br>Prior to commissioning, correct installation ~~for mechanical securement and containment~~ per manufacturer's specifications shall be confirmed. | | |
| First Revision Text (FR) | 13.3* Commissioning.<br>Prior to commissioning, correct installation ~~per~~in accordance with manufacturer'~~'~~s specifications~~for mechanical securement and containment~~ shall be confirmed.<br>~~A.13.3~~<br>~~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. | | |

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| Response<br>(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 |
|---|---|---|---|
| 13.4 | 205 | None | ☒~~☐~~ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 13.4* Operation and Maintenance.<br><br>~~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.<br><br>13.4.1<br><br>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.<br><br>13.4.2*<br><br>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.<br><br>13.4.3 Spin Down.<br><br>13.4.3.1<br><br>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.<br><br>13.4.3.2<br><br>The technician shall make certain that they have confirmed the maximum spin down time for safety reasons. | | |
| First Revision Text (FR) | 13.4* Operation and Maintenance.<br><br>~~As part of routine maintenance there shall be procedures for monitoring/checking for bearing wear.~~<br><br>13.4.1*<br><br>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~~ | | |

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| | ~~maintenance procedures have both a process for determining the bearing change interval and follow-up procedures.~~<br><br>A.13.4.1<br><br>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.<br><br>13.4.2*<br><br>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.<br><br>A.13.4.2<br><br>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.<br><br>13.4.3 Spin Down.<br><br>13.4.3.1<br><br>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.<br><br>13.4.3.2<br><br>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.<br><br>For 13.4.1, the AHJ may not be qualified for these activities, so “AHJ” was changed to “operator”.<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 3.x Energy Storage System Limited-Production Certification (LPC):<br>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):<br>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<br>☐ Resolve |
| Proposed Text (PI) | 3.x Appropriate Test Standard:<br>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:<br>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 | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | 3.x ESS Field Evaluation:<br>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.<br>A.3.xx<br>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:<br>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.<br>A.3.xx<br>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.<br>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 | | | |

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| 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<br>☒☐ Resolve |
| Proposed Text (PI) | 3.x Recognized Laboratory:<br>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<br>☒☐ Resolve |
| Proposed Text (PI) | Listed Energy Storage System.<br>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, | | |

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|---|---|
| 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<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | 4.6.1* Listings.<br><br>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~~<br><br>~~☒☐ Resolve~~ |
| Proposed Text (PI) | 4.6.1* Listings.<br><br>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. | | |

| A.4.6.1 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 163, 245 | ~~245~~ | ☐ Create First Revision<br><br>☒~~☐~~ Resolve |
| Proposed Text (PI) | A.4.6.1<br><br>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.~~<br><br>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. | | |
| 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) | Covered by first revision in Guidance document 4.6.2. | | |
| ~~A.4.6.1~~ | ~~All PIs used for FR or Resolve~~ | ~~Other PIs that propose revisions for this section~~ | ~~MOTION~~ |
| | ~~245~~ | ~~163~~ | ~~☐ Create First Revision~~<br><br>~~☒☐ Resolve~~ |
| Proposed Text (PI) | A.4.6.1<br><br>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.<br><br>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. | | |

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|---|---|
| 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.<br><br>ESS shall be listed in accordance with UL 9540, unless specifically exempted in other sections of this standard.<br><br>A.4.6.1<br><br>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.<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 9.2.1.1<br><br>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) | | | |

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|---|---|
| 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<br>☒ ~~☐~~ Resolve |
| Proposed Text (PI) | 9.2.2.1*<br><br>Existing lithium-ion ESS that are not UL 9540 listed shall require a hazard mitigation analysis in accordance with Section 4.4.<br><br>A.9.2.2.1<br><br>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<br>☒ ~~☐~~ Resolve |
| Proposed Text (PI) | 9.6.5.5.2<br><br>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) | | | |

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|---|---|
| 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) | |

<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 Section 4.6.2</td><td>CI</td><td></td><td>☒☐ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3"></td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">
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
</td></tr>
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|---|---|
| | 3. A Field Evaluation Body (FEB) accredited in accordance with NFPA 790 for evaluating energy storage systems in accordance with UL 9540.<br><br>**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.<br><br>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.<br><br>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.<br><br>**4.6.2.3 UL9540 Evaluation.**<br>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.<br><br>**4.6.2.4 * Functional Safety.**<br>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.<br><br>**A.4.6.2.4** The standards referred in UL 1973 and UL 9540 for functional safety are:<br>a) UL 991 and UL 1998;<br>c) Annex H of UL 60730-1 (Function Class B requirements);<br>d) IEC 61508 (all parts) (minimum of Safety Integrity Level (SIL) "2" requirements for active protective devices with software controls);<br>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).<br><br>**4.6.2.5 * Battery listings.**<br>All battery cells, modules or rack-mounted-modules in the ESS shall be listed and labeled in accordance with UL 1973.<br><br>**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.<br><br>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.<br><br>**4.6.2.6 * Applicability.**<br>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.<br><br>**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.<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | **2.2 NFPA Publications.**<br>National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.<br>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<br>☐ 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. | | |

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| | 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<br><br>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<br>☐ 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.<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 2.3.7 UL Publications.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, *Fire Tests of Building Construction and Materials*, 2021.<br><br>UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018.<br><br>UL 1012, *Power Units Other Than Class 2*, 2021.<br><br>UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021.<br><br>UL 1778, *Uninterruptible Power Systems*, 2017.<br><br>UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications*, ~~2018~~ 2022.<br><br>UL 1974, *Evaluation for Repurposing Batteries*, 2018.<br><br>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.<br><br>UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019.<br><br>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~~<br><br>~~☐ Resolve~~ |
| Proposed Text (PI) | 2.3.7 UL Publications.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, *Fire Tests of Building Construction and Materials*, 2021.<br><br>UL 790, *Standard Test Methods for Fire Tests of Roof Coverings*, 2018.<br><br>UL 1012, *Power Units Other Than Class 2*, 2021.<br><br>UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, 2021.<br><br>UL 1778, *Uninterruptible Power Systems*, 2017.<br><br>UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* 2018.<br><br>UL 1974, *Evaluation for Repurposing Batteries*, 2018.<br><br>UL 9540, *Energy Storage Systems and Equipment*, 2020.<br><br>~~UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.~~<br><br>UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.<br><br>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<br>(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<br>(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~~<br><br>~~☐ Resolve~~</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">2.3.7 UL Publications.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, Fire Tests of Building Construction and Materials, ~~2021~~2011, revised 2022.<br><br>UL 790, Standard Test Methods for Fire Tests of Roof Coverings, ~~2018~~2022.<br><br>UL 1012, Power Units Other Than Class 2, 2010, revised 2021.<br><br>UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, 2021, revised 2023.<br><br>UL 1778, Uninterruptible Power Systems, ~~2017~~2014, revised 2023.<br><br>UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, ~~2018~~ 2022.<br><br>CAN/UL 1974, Evaluation for Repurposing Batteries, 2018.<br><br>CAN/UL 9540, Energy Storage Systems and Equipment, ~~2020~~2021.<br><br>CAN/UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019.<br><br>UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.<br><br>UL 62368-1, Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements, 2021.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">2.3.7 UL Publications.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, Fire Tests of Building Construction and Materials, ~~2021~~2011, revised 2022.<br><br>UL 790, Standard Test Methods for Fire Tests of Roof Coverings, ~~2018~~2022.</td></tr>
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<table>
<tr><td></td><td colspan="3">UL 1012, Power Units Other Than Class 2, <u>2010, revised </u>2021.<br><br>UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, 2021<u>, revised 2023</u>.<br><br>UL 1778, Uninterruptible Power Systems, <s>2017</s><u>2014, revised 2023</u>.<br><br>UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,<s> 2018 </s><u>2022</u>.<br><br><u>CAN/</u>UL 1974, Evaluation for Repurposing Batteries, 2018.<br><br><u>CAN/</u>UL 9540, Energy Storage Systems and Equipment, <s>2020</s><u>2023</u>.<br><br><u>CAN/</u>UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019.<br><br>UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.<br><br>UL 62368-1, Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements, 2021.</td></tr>
<tr><td>Statement<br>(technical reason for FR)</td><td colspan="3">Standards are being updated to current editions.</td></tr>
<tr><td>Response<br>(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>340</td><td></td><td>☐ Create First Revision<br><br>☒<s>☐</s> Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">2.3.7 UL Publications.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, Fire Tests of Building Construction and Materials, 2021.<br><br>UL 790, Standard Test Methods for Fire Tests of Roof Coverings, 2018.<br><br>UL 1012, Power Units Other Than Class 2, 2021.<br><br>UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, 2021.<br><br>UL 1778, Uninterruptible Power Systems, 2017.<br><br>UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, 2018.<br><br>UL 1974, Evaluation for Repurposing Batteries, 2018.</td></tr>
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| | UL 3202, Outline of Investigation for EV Charging Systems Utilizing Energy Storage, 2023<br><br>UL 9540, *Energy Storage Systems and Equipment*, 2020.<br><br>UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019.<br><br>UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, 2007, revised 2019.<br><br>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.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 263, Fire Tests of Building Construction and Materials, ~~2021~~ 2011.<br><br>UL 790, Standard Test Methods for Fire Tests of Roof Coverings, 2018.<br><br>UL 1012, Power Units Other Than Class 2, ~~2021~~ 2010.<br><br>UL 1741, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, 2021.<br><br>UL 1778, Uninterruptible Power Systems, ~~2017~~ 2014.<br><br>UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications, ~~2018~~ 2022.<br><br>CAN/UL 1974, Evaluation for Repurposing Batteries, 2018.<br><br>CAN/UL 9540, Energy Storage Systems and Equipment, ~~2020~~ 2021.<br><br>~~UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019.~~ | |

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|---|
| UL 60950-1, Information Technology Equipment — Safety — Part 1: General Requirements, 2007, revised 2019.<br><br>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<br><br>☒ Resolve |
| Proposed Text (PI) | 4.4.5*<br><br>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*<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | A.4.6.9.1<br><br>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. | | |

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|---|---|
| First Revision Text (FR) | A.4.6.9.1<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 3.3.8* Energy Storage Management System (ESMS).<br><br>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).<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | A.3.3.9.4<br><br>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 | | |

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| | 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.<br><br>An enclosure ~~structure~~ or containering of an energy storage systems ~~that includes~~ equipped with a means (such as a doors) ~~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~~.<br><br>A.3.3.9.4<br><br>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.<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 3.3.16 Maximum Stored Energy.<br><br>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. | | |

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| | 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.<br><br>A.3.3.16<br><br>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.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 3.3.20 Qualified Person.<br><br>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.<br><br>3.3.20 Qualified Person.<br><br>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. | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | Stored Energy.<br>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.<br>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<br>☐ Resolve |
| Proposed Text (PI) | Thermal Walkaway<br>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<br>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. | | |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | **4.6.12.2**<br><br>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 *<br><br>~~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.<br><br>A.4.6.12.2<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 4.7.2 Seismic Protection.<br><br>ESS shall ~~be seismically braced~~ meet seismic requirements in accordance with the local building code. | | |
| First Revision Text (FR) | 4.7.2 Seismic Protection.<br><br>ESS shall ~~be seismically braced~~meet seismic requirements in accordance with the ~~local~~ applicable building codes. | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 4.7.4.3.1<br><br>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<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 4.7.~~7.~~1~~.2~~<br><br>The ESS shall not be located inside an electrical room.<br><br>4.7.~~7.1.3~~2<br><br>The ESS shall be accessible to emergency responders without traversing through an electrical room. | | |

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| First Revision Text (FR) | 4.7.1<br>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.<br><br>~~4.7.7.1.2~~<br><br>~~The ESS shall not be located inside an electrical room.~~<br><br>~~4.7.7.1.3~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 7.2.5.2<br><br>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<br><br>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.<br><br>7.2.5.3<br><br>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). | | |

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| Response<br>(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<br>☐ Resolve |
| Proposed Text (PI) | 9.2.3.1*<br>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*<br>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<br>(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<br>☐ Resolve |
| Proposed Text (PI) | 9.2.3.2*<br>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* | | |

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| | 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<br><br>☐ Resolve |
| Proposed Text (PI) | ~~9.5.2.1 HMA.~~<br><br>~~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.~~<br><br>~~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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.5.3.2 Mobile ESS Equipment and Operations.<br><br>Mobile ESS operation shall be classified as specified in 9.5.3.2.~~1~~2 or 9.5.3.2.3. | | |

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| | I have not included subsections not being changed.<br><br>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. | | |
| First Revision Text (FR) | 9.5.3.2 Mobile ESS Equipment and Operations.<br><br>~~Mobile ESS operation shall be classified as specified in 9.5.3.2.1 or 9.5.3.2.2~~ | | |
| Statement (technical reason for FR) | Section 9.5.3.2 is incorrectly referencing the subsections. Removing the references to the subsections makes it read better. | | |
| Response (technical reason for not making some changes or for resolving) | 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. | | |
| | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
| | Carry over from PI 27 | 365 | ☒ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.5.3.2.1.2<br><br>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. | | |
| First Revision Text (FR) | ~~9.5.3.2.1.2~~<br>~~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.~~ | | |
| Statement (technical reason for FR) | 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. | | |
| Response (technical reason for not making some changes or for resolving) | | | |
| | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |

| | | | |
|---|---|---|---|
| | Carry over from PI 27 | 365 | ☒☐ Create First Revision<br><br>☐ Resolve |
| Proposed Text (PI) | 9.5.3.2.2.2<br><br>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<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | A.9.6.5.1<br><br>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.<br><br>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<br><br>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. | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.2* Spill Control.<br>A.9.6.5.2<br>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.<br>A.9.6.5.2<br>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<br>☐ Resolve |

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| Proposed Text (PI) | 9.6.5.2.1<br><br>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<br><br>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<br><br>☐ Resolve |

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| Proposed Text (PI) | A.9.6.5.3.1<br><br>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<br><br>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. |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.4* Safety Caps.<br><br>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.<br><br>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.<br><br>A.9.6.5.4<br><br>If recombination caps are used they should contain evaluated flame arresters.<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | 9.6.5.5* Thermal Runaway Protection.<br>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.<br>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<br>☐ Resolve |
| Proposed Text (PI) | A.9.6.5.5<br>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.<br>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<br><br>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.<br><br>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. |
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| 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<br><br>☐ Resolve |

| Proposed Text (PI) | 11.1.1<br><br>Stationary fuel cell ESS shall comply with the following requirements of Chapter 4 and Chapter 9:<br><br>(1) Charge controllers *(see 4.6.8)*<br><br>(2) Inverters and converters *(see 4.6.9)*<br><br>(3) Energy storage management system (ESMS) *(see 4.6.10)*<br><br>(4) Impact protection *(see 4.7.5)*<br><br>(5) Smoke and fire detection *(see Section 4.8)*<br><br>(6) Fire control and suppression *(see Section 4.9)*<br><br>(7) Water supply *(see 4.9.4)* |
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| | (8) Signage *(see 4.7.4)*<br>(9) Combustible storage *(see Section 4.5)*<br>(10) Hazard mitigation analysis *(see Section 4.4)*<br>(11) Emergency planning and training *(see Section 4.3)*<br>(12) Construction documents *(see Section 4.2)*<br>(13) Spill Control (see Section 9.6.5.2) |
| First Revision Text (FR) | 11.1.1<br><br>Stationary fuel cell ESS shall comply with the following ~~requirements of Chapter 4~~:<br><br>1. Charge controllers *(see 4.6.8)*<br>2. Inverters and converters *(see 4.6.9)*<br>3. Energy storage management system (ESMS) *(see 4.6.10)*<br>4. Impact protection *(see 4.7.5)*<br>5. Smoke and fire detection *(see Section 4.8)*<br>6. Fire control and suppression *(see Section 4.9)*<br>7. Water supply *(see 4.9.4)*<br>8. Signage *(see 4.7.4)*<br>9. Combustible storage *(see Section 4.5)*<br>10. Hazard mitigation analysis *(see Section 4.4)*<br>11. Emergency planning and training *(see Section 4.3)*<br>12. Construction documents *(see Section 4.2)*<br>~~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<br>☐ Resolve |
| Proposed Text (PI) | 6.1.1.1<br><br>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 <u>battery requirements</u> 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<br><br>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 <u>battery requirements</u> 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<br>☒ Resolve |
| Proposed Text (PI) | 6.1.3.2<br><br>The commissioning plan shall include, but not be limited to, the following information:<br>(1) An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted<br>(2) Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s)<br>(3) Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s) | | |

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| | (4) Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems<br>(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<br>(6) Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems<br>(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<br>(8) The following documentation:<br>(a) Commissioning checklist<br>(b) Relevant operational testing forms<br>(c) Necessary commissioning logs<br>(d) Progress reports<br>(9) Means and methods whereby facility operation and maintenance staff will be trained on the system<br>(10) Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system<br>~~(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<br>☐ Resolve |
| Proposed Text (PI) | | | |

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| First Revision Text (FR) | See below for revised text. |
| Statement<br>(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.<br><br>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<br>(technical reason for not making some changes or for resolving) | |
| First Revision Text (FR) | 6.1.3.2*<br><br>The commissioning plan shall include, but not be limited to, the following information:<br><br>1. An overview of the commissioning process developed specifically for the ESS to be installed and narrative description of the activities to be conducted<br><br>2. Roles and responsibilities for all those involved in the design, commissioning, construction, installation, or operation of the system(s)<br><br>3. Means and methods whereby the commissioning plan will be made available during the implementation of the ESS project(s)<br><br>4. Plans and specifications necessary to understand the operation of the ESS and all associated operational controls and safety systems<br><br>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<br><br>6. Procedures to be used in documenting the proper operation of the ESS and all associated operational controls and safety systems<br><br>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<br><br>8. The following documentation:<br><br>a. Commissioning checklist<br><br>b. Relevant operational testing forms<br><br>c. Necessary commissioning logs |

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| | d. Progress reports<br><br>9. Means and methods whereby facility operation and maintenance staff will be trained on the system<br><br>10. Identification of personnel who are qualified to service and maintain the system and respond to incidents involving each system<br><br>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.<br><br>A.6.1.3.2<br><br>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:<br><br>1. ESS input and output power should track the commands<br><br>2. ESS shuts down when shut-down command is sent.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 6.1.4.2<br><br>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<br><br>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~~. | | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | 6.3.1<br>~~Operations~~ The ESS owner shall maintain operations and maintenance documentation ~~shall be provided to the ESS owner~~. | | |
| First Revision Text (FR) | 6.3.1<br>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<br>☐ Resolve |
| Proposed Text (PI) | A.6.4.2<br>Listed software changes completed as part of providing new operating modes or functions should be considered system renewals ~~because it is a listed change~~. | | |

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| First Revision Text (FR) | A.6.4.2<br><br>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.<br><br>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<br><br>☐ Resolve |

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| Proposed Text (PI) | 8.1.2*<br><br>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*<br><br>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 | |

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| 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<br><br>☐ Resolve |
| Proposed Text (PI) | 8.1.3*<br><br>The decommissioning plan shall be provided to the AHJ and include the following information:<br><br>(1) An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned<br><br>(2) Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site<br><br>(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~~<br><br>(4) Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained<br><br>(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<br><br>(6) Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned<br><br>(7) Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports<br><br>(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*<br><br>The decommissioning plan shall be provided to the AHJ and include the following information:<br><br>1. An overview of the decommissioning process developed specifically for the ESS that is to be decommissioned<br>2. Roles and responsibilities for all those involved in the decommissioning of the ESS and their removal from the site<br>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~~<br>4. Plans and specifications necessary to understand the ESS and all associated operational controls and safety systems, as built, operated, and maintained | | |

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| | 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<br>6. Procedures to be used in documenting the ESS and all associated operational controls and safety systems that have been decommissioned<br>7. Guidelines and format for a decommissioning checklist and relevant operational testing forms and necessary decommissioning logs and progress reports<br>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<br><br>☐ Resolve |
| Proposed Text (PI) | 2.3.2 ASTM Publications.<br><br>ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.<br><br>ASTM E108, *Standard Test Methods for Fire Tests of Roof Coverings*, 2020a.<br><br>ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, ~~2020~~2022. | | |
| First Revision Text (FR) | 2.3.2 ASTM Publications.<br><br>ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.<br><br>ASTM E108, Standard Test Methods for Fire Tests of Roof Coverings, 2020a.<br><br>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<br><br>☐ Resolve |
| Proposed Text (PI) | C.3 Suppression Systems.<br><br>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 | | |

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| | 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. |
| First Revision Text (FR) | C.3 Suppression Systems.<br><br>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. |
| Statement (technical reason for FR) | 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. |
| Response (technical reason for not making some changes or for resolving) | |

| C.3 | All PIs used for FR or Resolve | Other PIs that propose revisions for this section | MOTION |
|---|---|---|---|
| | 330 | 269 | ☐ Create First Revision<br><br>☒ Resolve |

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| Proposed Text (PI) | C.3 Suppression Systems.<br><br>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. |
| First Revision Text (FR) | |
| Statement (technical reason for FR) | |

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| 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<br>☐ Resolve |
| Proposed Text (PI) | C.4.2 Fires.<br>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.<br>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.<br>Proper response to electrochemical ESS fires should include the following procedures and steps:<br>(1) System isolation and shutdown<br>(2) Hazard confinement and exposure protection<br>(3) Fire suppression<br>(4) Ventilation | | |
| First Revision Text (FR) | C.4.2 Fires.<br>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.<br>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.<br>Proper response to electrochemical ESS fires should include the following procedures and steps:<br>(1) System isolation and shutdown | | |

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| | (2) Hazard confinement and exposure protection<br><br>(3) Fire suppression<br><br>(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<br><br>☒☐ Resolve |
| Proposed Text (PI) | C.5.1 Lithium-Ion (Li-ion) Batteries.<br><br>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.<br><br>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. |

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| 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<br>☒ 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.<br><br>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<br>☒ Resolve |
| Proposed Text (PI) | H.1.1 NFPA Publications.<br><br>National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.<br><br>NFPA 1, *Fire Code*, 2021 edition.<br><br>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.

<table>
<tr><td colspan="1"></td><td colspan="3">NFPA 550, Guide to the Fire Safety Concepts Tree, 2022 edition.<br><br>NFPA 551, Guide for the Evaluation of Fire Risk Assessments, 2022 edition.<br><br>NFPA 652, Standard on the Fundamentals of Combustible Dust, 2019 edition.<br><br>NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, 2022 edition.<br><br>NFPA 750, Standard on Water Mist Fire Protection Systems, 2023 edition.<br><br>NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2020 edition.<br><br>NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2020 edition.<br><br>NFPA 921, Guide for Fire and Explosion Investigations, 2021 edition.<br><br>NFPA 1221, Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems, 2019 edition.<br><br>NFPA 1620, Standard for Pre-Incident Planning, 2020 edition.<br><br>NFPA 1962, Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances, 2018 edition.<br><br>NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2022 edition.<br><br>NFPA 2010, Standard for Fixed Aerosol Fire-Extinguishing Systems, 2020 edition.<br><br>Fire Protection Handbook, ~~20th~~ 21st edition, ~~2008~~2023.</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">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.</td></tr>
<tr><td rowspan="2">H.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>369</td><td>~~211~~</td><td>☐ Create First Revision<br><br>☒ ~~☐~~ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">H.1.1 NFPA Publications.<br><br>National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.<br><br>NFPA 1, Fire Code, 2021 edition.</td></tr>
</table>

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.

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|---|---|
| | NFPA 550, *Guide to the Fire Safety Concepts Tree,* 2022 edition.<br><br>NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2022 edition.<br><br>NFPA 652, *Standard on the Fundamentals of Combustible Dust*, 2019 edition.<br><br>NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2022 edition.<br><br>NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.<br><br>NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants,* 2020 edition.<br><br>NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2020 edition.<br><br>NFPA 921, *Guide for Fire and Explosion Investigations*, 2021 edition.<br><br>NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition.<br><br>NFPA 1620, *Standard for Pre-Incident Planning*, 2020 edition.<br><br>NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances*, 2018 edition.<br><br>NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition.<br><br>NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*, 2020 edition.<br><br>*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<br><br>☐- Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | See below for revised text. | | |

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|---|---|
| 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.

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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<br>☐ Resolve |
| Proposed Text (PI) | H.1.2.11 UL Publications.<br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. | | |

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| | UL 1012, *Power Units Other Than Class 2*, 2010, revised 2021.<br><br>UL 1642, *Lithium Batteries*, 2020, revised 2022.<br><br>UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*, ~~2018~~2023.<br><br>UL 1778, *Uninterruptible Power Systems*, ~~2017~~2014, revised 2023.<br><br>CAN/UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* ~~2018~~ 2022.<br><br>CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2018.<br><br>UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020.<br><br>ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019.<br><br>UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019.<br><br>UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2021.<br><br>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.<br><br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br><br>UL 1012, *Power Units Other Than Class 2*, 2010 revised 2021.<br><br>UL 1642, *Lithium Batteries*, 2020 revised 2022.<br><br>UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*~~, 2018~~ 2023.<br><br>UL 1778, *Uninterruptible Power Systems*, ~~2017~~ 2014 revised 2023.<br><br>CAN/UL 1973, *Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications,* ~~2018~~ 2022.<br><br>CAN/UL 1974, *Evaluation for Repurposing Batteries,* 2018.<br><br>UL 2436, *Outline of Investigation for Spill Containment for Stationary Acid and Alkaline Electrolyte Battery Systems,* 2020.<br><br>ANSI/UL 2775, *Standard for Fixed Condensed Aerosol Extinguishing System Units,* 2019.<br><br>UL 62109-1, *Safety of Power Converters for Use in Photovoltaic Power Systems — Part 1: General Requirements*, 2014, revised 2019.<br><br>UL 9540, *Energy Storage Systems and Equipment*, ~~2020~~2021.<br><br>CAN/UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019. |

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|---|---|
| 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<br>☐ Resolve |
| Proposed Text (PI) | H.1.2.14.1 References for Annex D.<br><br>1. International Electrotechnical Commission (IEC), “Electrical Energy Storage,” White Paper, Geneva/Switzerland, pp. 17–34, December 2011.<br><br>2. Rastler, D., “Electricity Energy Storage Technology Option,” Electric Power Research Institute, December 2010.<br><br>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.<br><br>4. Xie, S., and L. S. Wang, “Industry Trends — Issue 9,” China Energy Storage Alliance, January 2012.<br><br>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.<br><br>6. Nakhamkin, M., “Novel Compressed Air Energy Storage Concepts,” developed by Energy Storage and Power Consultants (ESPC) and presented to EESAT, May 2007.<br><br>7. Inage, Shin-ichi, “Prospects for Large-Scale Energy Storage in Decarbonised Grids,” International Energy Agency, Report, 2009.<br><br>8. Schossig, P., “Thermal Energy Storage,” 3rd International Renewable Energy Storage Conference, Berlin, Germany, November 2012.<br><br>9. Fairley, P., http://spectrum.ieee.org/energy/environment/largest-solar-thermal-storage-plant-to-start-up, Article 2008, Accessed ~~July 2011~~ May 2023.<br><br>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.<br><br>11. Tamme, R., “Development of Storage Systems for SP Plants,” DG TREN—DG RTD Consultative Seminar on Concentrating Solar Power, Brussels, Belgium, June 2006. | | |

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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. |
| 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.




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| 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. |

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|---|---|
| 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<br>☐ Resolve |
| Proposed Text (PI) | H.1.2.14.2.3 UL Publications.<br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br>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.<br>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.<br>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<br>☒☐ Resolve |
| Proposed Text (PI) | H.1.2.14.3 Other Publications.<br>DNVGL Battery Safety Joint Development Project Report, "Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression," January 7, 2020.<br>Marioff Corporation—Fire Test Summary #57/BR/AUG15, "HI-FOG® Systems for Protection of Li-ion Rooms," August 2015. | | |

<table>
<tr><td></td><td colspan="3">“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.</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">It is not necessary to show a particular paper or publication was accessed.</td></tr>
<tr><td rowspan="2">New H.1.2.14.4 or add to H.1.2.14.3?</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>370</td><td>~~130?~~</td><td>☒☐ Create First Revision<br>☐ Resolve</td></tr>
<tr><td>Proposed Text (PI)</td><td colspan="3">H.1.2.14.3 Other Publications.<br><br>DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020.<br><br>Marioff Corporation—Fire Test Summary #57/BR/AUG15, “HI-FOG® Systems for Protection of Li-ion Rooms,” August 2015.<br><br>“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<br><br>H1.2.14.2.4 NIOSH- Comparison of Fire Suppression Techniques on Lithium Ion Battery Pack Fires</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">See below for revision.</td></tr>
<tr><td>Statement (technical reason for FR)</td><td colspan="3">The NIOSH report is a document for reference purposes.</td></tr>
<tr><td>Response (technical reason for not making some changes or for resolving)</td><td colspan="3">The NIOSH report is just another publication and does not warrant being made a separate section.</td></tr>
<tr><td>First Revision Text (FR)</td><td colspan="3">H.1.2.14.3 Other Publications.<br><br>DNVGL Battery Safety Joint Development Project Report, “Technical Reference for Li-ion Battery Explosion Risk and Fire Suppression,” January 7, 2020.</td></tr>
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| | Marioff Corporation—Fire Test Summary #57/BR/AUG15, "HI-FOG® Systems for Protection of Li-ion Rooms," August 2015.<br><br>"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<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 3.3.X Emergency Power Supply System (EPSS).<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 3.3.X Stored-Energy Emergency Power Supply System (SEPSS).<br><br>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 | | |

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| | 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<br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 3.3.x* Reliability<br><br>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].<br><br>A.3.3.X<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | | | |
| First Revision Text (FR) | 3.3.x* Critical Safety Component or System<br><br>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).<br><br>A.3.3.x<br><br>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<br>☐ Resolve |
| Proposed Text (PI) | | | |

| | |
|---|---|
| First Revision Text (FR) | **4.10 Emergency Power Standby systems**<br><br>Critical safety systems shall be provided with reliable EPSS or SEPSS power.<br><br>**4.10.1** EPSS or SEPSS shall be a Class X, Type 10, Level 2.<br><br>**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.<br><br>**4.10.1.1** EPSS shall comply with NFPA 110<br><br>**4.10.1.2** SEPSS shall comply with NFPA 111.<br><br>**4.10.2*** A registered design professional with fire protection background shall evaluate the duration and total load requirements for the EPSS and SEPSS.<br><br>**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.<br><br>**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.<br><br>**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

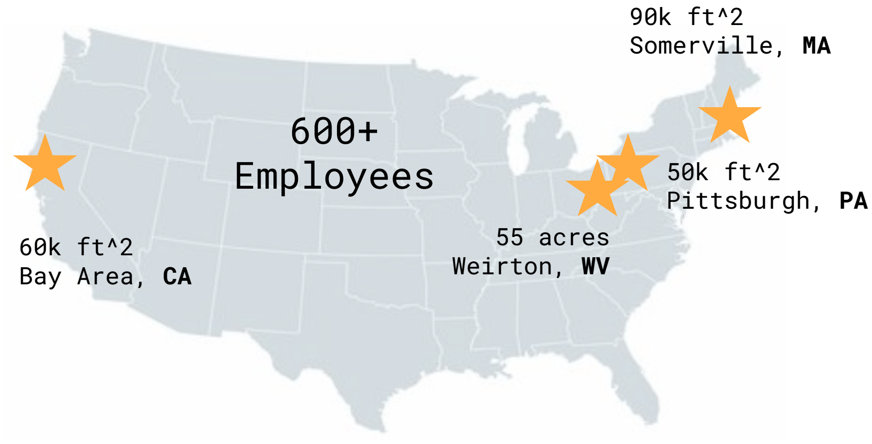
Energy Storage
For A Better World



# 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




## LED BY ENERGY STORAGE VETERANS

Decades of cumulative experience in energy storage

- 100's of MW of storage deployed

## 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

# 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

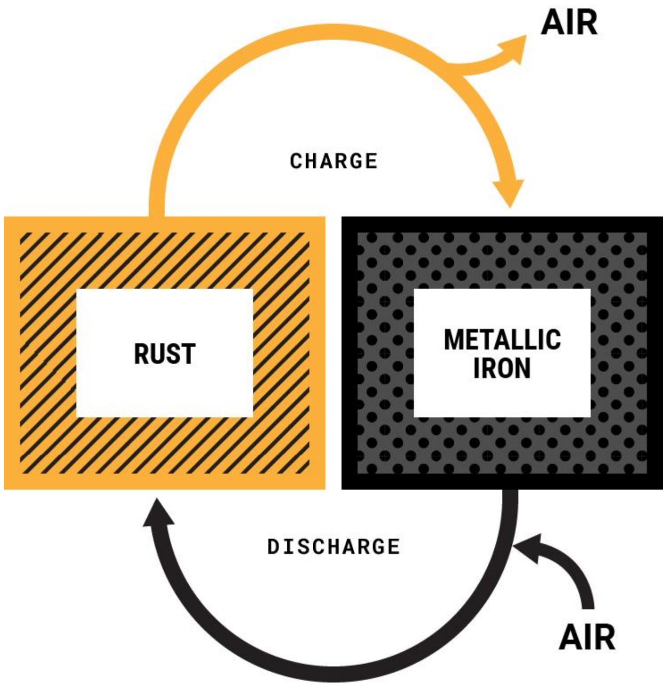
**15 MW / 1500 MWh** MDS system in Georgia to come online as early as 2026

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




## 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.

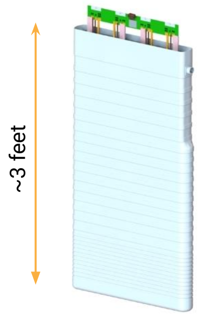
## DURABILITY

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

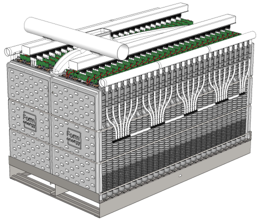
### Cell




Electrodes + Electrolyte

Smallest **Electrochemical** Functional Unit

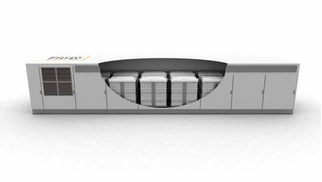
### Battery Module



~50 **Cells**

Smallest Building Block of **DC** Power

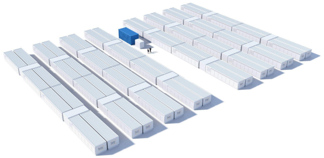
### Enclosure



~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?