Energy Storage System Safety Roadmap Codes and Standards Update

SAND2018-2619PE

Web Meeting

March 13, 2017

Hosted by

Pam Cole
Pacific Northwest National Laboratory

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Energy Storage System Safety Roadmap
Codes and Standards Update

2:00 p.m. – 2:05 p.m.	Welcome, Purpose, Expected Outcome and Overview of the Webinar
2:05 p.m. – 2:10 p.m.	ESS Safety Roadmap Codes and Standards Objective and Efforts
2:10 p.m. – 4:00 p.m.	Update on standards/model codes activities (ASME, DNV GL, FM Global, ICC, CSA, NECA, NFPA, UL, NEMA, and IEEE)
4:00 p.m.	Adjourn

Energy Storage System Safety Roadmap
Codes and Standards Update

Purpose of the meeting

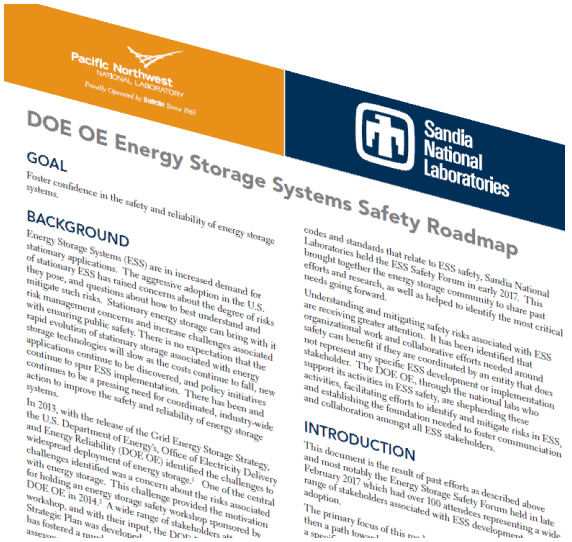
Report on current activities in the voluntary sector codes and standards community that are relevant to ESS safety

Expected Outcome

An update on development of new standards and updating of existing standards and model codes impacting ESS design, construction, installation, commissioning, operation, repair, renewal and decommissioning

ESS Safety Roadmap Update

- Supported by the DOE Office of Electricity Energy Storage Program
- The goal of the DOE OE ESS Safety Roadmap is to *foster confidence in the safety and reliability of energy storage systems.*
- Roadmap objective focused on codes and standards - To apply research and development to support efforts that are focused on ensuring that codes and standards (CS) are available to enable the safe implementation of energy storage systems in a comprehensive, non-discriminatory and science-based manner.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DOE OE Energy Storage Systems Safety Roadmap

GOAL

Foster confidence in the safety and reliability of energy storage systems.

BACKGROUND

Energy Storage Systems (ESS) are in increased demand for stationary applications. The aggressive adoption in the U.S. of stationary ESS has raised concerns about the degree of risks they pose, and questions about how to best understand and mitigate such risks. Stationary energy storage can bring with it risk management concerns and increase challenges associated with ensuring public safety. There is no expectation that the rapid evaluation of stationary storage associated with energy storage technologies will slow as the costs continue to fall, new applications continue to be discovered, and policy initiatives continue to spur ESS implementation. There has been and continues to be a pressing need for coordinated, industry-wide actions to improve the safety and reliability of energy storage systems.

In 2013, with the release of the Grid Energy Storage Strategy, the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability (DOE OE) identified the challenges to widespread deployment of energy storage.[1] One of the central challenges identified was a concern about the risks associated with energy storage. This challenge provided the motivation for holding an energy storage safety workshop sponsored by DOE OE in 2014.[2] A wide range of stakeholders at the workshop, and with their input, the DOE [illegible] Strategic Plan was developed [illegible] has fostered a [illegible] assess[illegible]

codes and standards that relate to ESS safety, Sandia National Laboratories held the ESS Safety Forum in early 2017. This brought together the energy storage community to shape past efforts and research, as well as helped to identify the most critical needs going forward.

Understanding and mitigating safety risks associated with ESS are receiving greater attention. It has been identified that organizational work and collaborative efforts needed around safety can benefit if they are coordinated by an entity that does not represent any specific ESS development or implementation stakeholder. The DOE OE, through the national labs who support its activities in ESS safety, are shepherding these activities, facilitating efforts to identify and mitigate risks in ESS, and establishing the foundation needed to foster communication and collaboration amongst all ESS stakeholders.

INTRODUCTION

This document is the result of past efforts as described above and most notably the Energy Storage Safety Forum held in late February 2017 which had over 100 attendees representing a wide range of stakeholders associated with ESS development and adoption.

The primary focus of this [illegible] then a path [illegible] a specific [illegible]

Acknowledgment

Dr. Imre Gyuk

DOE-Office of Electricity Delivery and Energy Reliability

U.S. DEPARTMENT OF ENERGY

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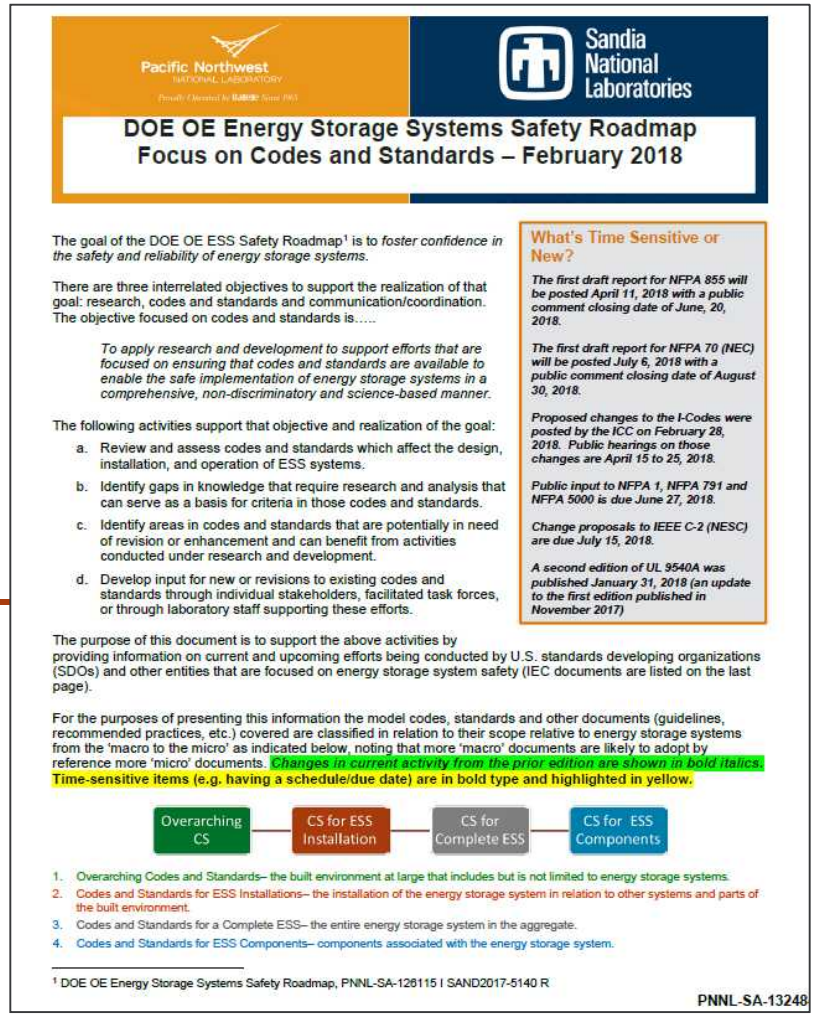
Overview of ESS Safety Codes and Standards Activities

Activities to support the codes and standards objective

1. Review and assess CS which affect ESS design, installation, and operation
2. Identify gaps in knowledge that require research and analysis that can serve as a basis for criteria in those CS.
3. Identify areas in CS that are potentially in need of revision or enhancement and can benefit from R&D activities.
4. Develop input for new or revisions to existing CS through individual stakeholders, facilitated task forces, or through laboratory staff supporting these efforts.



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DOE OE Energy Storage Systems Safety Roadmap
Focus on Codes and Standards – February 2018

The goal of the DOE OE ESS Safety Roadmap[1] is to *foster confidence in the safety and reliability of energy storage systems.*

There are three interrelated objectives to support the realization of that goal: research, codes and standards and communication/coordination. The objective focused on codes and standards is…..

To apply research and development to support efforts that are focused on ensuring that codes and standards are available to enable the safe implementation of energy storage systems in a comprehensive, non-discriminatory and science-based manner.

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

a. Review and assess codes and standards which affect the design, installation, and operation of ESS systems.
b. Identify gaps in knowledge that require research and analysis that can serve as a basis for criteria in those codes and standards.
c. Identify areas in codes and standards that are potentially in need of revision or enhancement and can benefit from activities conducted under research and development.
d. Develop input for new or revisions to existing codes and standards through individual stakeholders, facilitated task forces, or through laboratory staff supporting these efforts.

What's Time Sensitive or New?

The first draft report for NFPA 855 will be posted April 11, 2018 with a public comment closing date of June, 20, 2018.

The first draft report for NFPA 70 (NEC) will be posted July 6, 2018 with a public comment closing date of August 30, 2018.

Proposed changes to the I-Codes were posted by the ICC on February 28, 2018. Public hearings on those changes are April 15 to 25, 2018.

Public input to NFPA 1, NFPA 791 and NFPA 5000 is due June 27, 2018.

Change proposals to IEEE C-2 (NESC) are due July 15, 2018.

A second edition of UL 9540A was published January 31, 2018 (an update to the first edition published in November 2017)

The purpose of this document is to support the above activities by providing information on current and upcoming efforts being conducted by U.S. standards developing organizations (SDOs) and other entities that are focused on energy storage system safety (IEC documents are listed on the last page).

For the purposes of presenting this information the model codes, standards and other documents (guidelines, recommended practices, etc.) covered are classified in relation to their scope relative to energy storage systems from the 'macro to the micro' as indicated below, noting that more 'macro' documents are likely to adopt by reference more 'micro' documents. ***Changes in current activity from the prior edition are shown in bold italics.*** **Time-sensitive items (e.g. having a schedule/due date) are in bold type and highlighted in yellow.**

Overarching CS — CS for ESS Installation — CS for Complete ESS — CS for ESS Components

1. Overarching Codes and Standards– the built environment at large that includes but is not limited to energy storage systems.
2. Codes and Standards for ESS Installations– the installation of the energy storage system in relation to other systems and parts of the built environment.
3. Codes and Standards for a Complete ESS– the entire energy storage system in the aggregate.
4. Codes and Standards for ESS Components– components associated with the energy storage system.

[1] DOE OE Energy Storage Systems Safety Roadmap, PNNL-SA-126115 I SAND2017-5140 R

PNNL-SA-13248

Codes and Standards Update

Each SDO will present the following information

- Overview of the SDO Standards Development Process and other high level relevant information to set the stage for a summary of ESS-relevant standards activities.
- Identification of ESS-relevant standards activities as to title, scope, schedule, etc. and if desired some very high level insight on content (the webinar will not allow time to go into details associated with the standards covered).
- Web site for more information on their activities

The American Society of Mechanical Engineers

Development of TES-1 Safety Standard for Thermal Energy Storage Systems

AGENDA

- Overview of ASME and the Standards Development Process
- Development of TES-1, Safety Standard for Thermal Energy Storage Systems

OVERVIEW

ASME: Who We Are

Nonprofit Standards Development Organization

Key Areas:

Pressure Technology

Boilers, pressure vessels, piping, materials, welding, valves, flanges

Standardization/Performance Test Codes

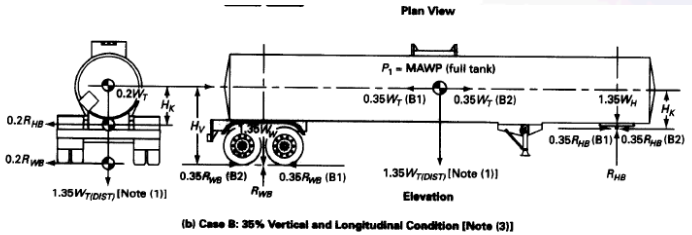
Geometric dimensioning and tolerancing (GD&T), dimensional metrology, plumbing, turbines and power plant equipment, fasteners, hand tools, energy assessment

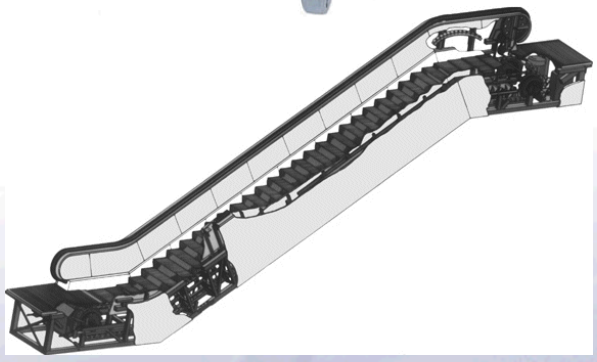
Safety

Elevators & escalators, cranes, automotive lifts, conveyors, rail transit

Nuclear

Component design, containment, quality assurance, risk assessment, air and gas treatment, inspection





ASME
SETTING THE STANDARD

History

Timeline of Early ASME Standardization Milestones

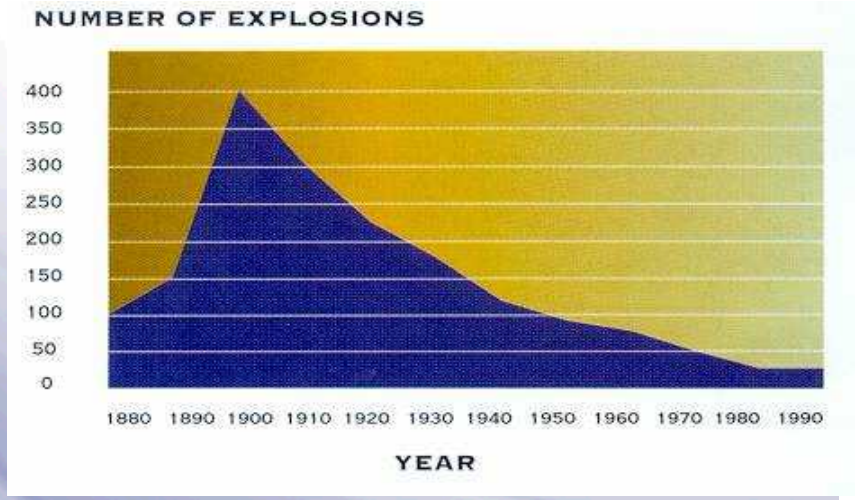
1880
ASME founded to address issues with industrialization and mechanization

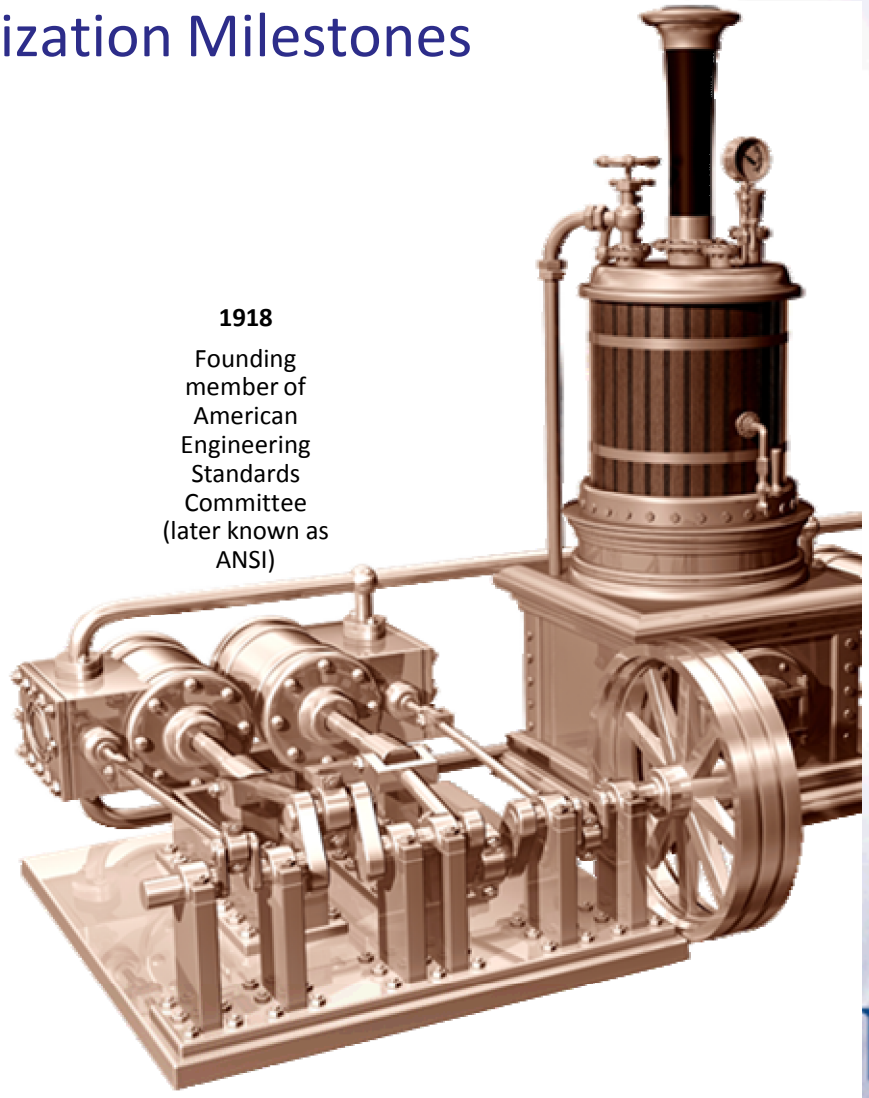
1884
Issues first standard, Code for the Conduct of Trials of Steam Boilers

1905
Standard for Proportions of Machine Screw Sizes

1914
First edition of the Boiler and Pressure Vessel Code

1918
Founding member of American Engineering Standards Committee (later known as ANSI)





OVERVIEW

ASME Standards Today

…by the numbers

- 500+ published standards (more recently, over 50 technical related non-standards publications)
- 4,900 volunteer subject matter experts from over 50 countries
- 700 boards, standards developing committees and supporting subgroups
- 40 U.S. Technical Advisory Groups (TAGs) to the International Organization for Standardization
- 6,500 certified companies (>50% non-U.S) in 74 countries

ASME
SETTING THE STANDARD

Accredited by ANSI

ANSI
American National Standards Institute

ANSI's *Essential Requirements* establish due process for standards development via:

- Openness
- Lack of dominance/Balance of interest
- Coordination and harmonization
- Consensus
- Consideration of views and objections
- Notification
- Written procedures
- Appeals

STANDARDIZATION

ASME Consensus Process

Submission
- Submission of proposal
- Proposal evaluation (staff, subgroup/subcommittee)

Technical Approval
- Proposal voted on by committee
- Disapprovals addressed/recirculated (iterative)

Review
- ANSI Public Review
- Pubic Review comments addressed

Procedural Approval
- ASME supervisory board procedural review/approval
- ANSI procedural approval

Publication
- Editing, composition, review of proof pages
- Publication

ASME
SETTING THE STANDARD

EMERGING AREAS

New Activities

MANUFACTURING

The technologies associated with traditional and advanced manufacturing from product design through to production.

PRESSURE TECHNOLOGY

The technologies applicable to the design, materials, fabrication, examination, installation, commissioning, and maintenance of pressure equipment.

CLEAN ENERGY

The technologies for electric power generation, storage, distribution, and usage while minimizing the impact on the environment.

BIOENGINEERING

The technologies associated with the application of the engineering process in developing products, pharmaceuticals, biologics, cosmetics, food supplements, and the prevention and treatment of disease.

ROBOTICS

The technologies for industrial machine systems and emerging areas such as service robots, drones, and autonomous vehicles.

TES-1 Safety Standard for Thermal Energy Storage Systems

Molten Salt Thermal Energy Store Systems

ASME
SETTING THE STANDARD

DEVELOPMENT

Surveys: 2 Industry Surveys Issued

Results: Interest in developing a safety guideline related to thermal energy storage systems.

Current: TES-1 Development of Safety Standard for Molten Salt Thermal Energy Storage Systems

Future: TES-2: Safety Standard for Thermal Energy Storage Systems Requirements for Phase Change, Solid and Other Thermal Energy Storage Systems

DEVELOPMENT

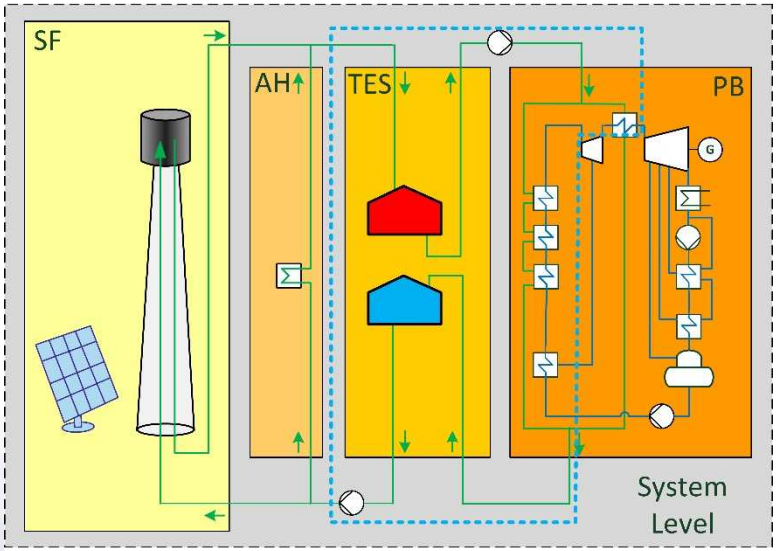
TES Charter

To develop and maintain safety codes and standards covering the design, construction, testing, maintenance, and operation of thermal energy storage systems for the life cycle of the equipment.

DEVELOPMENT Scope

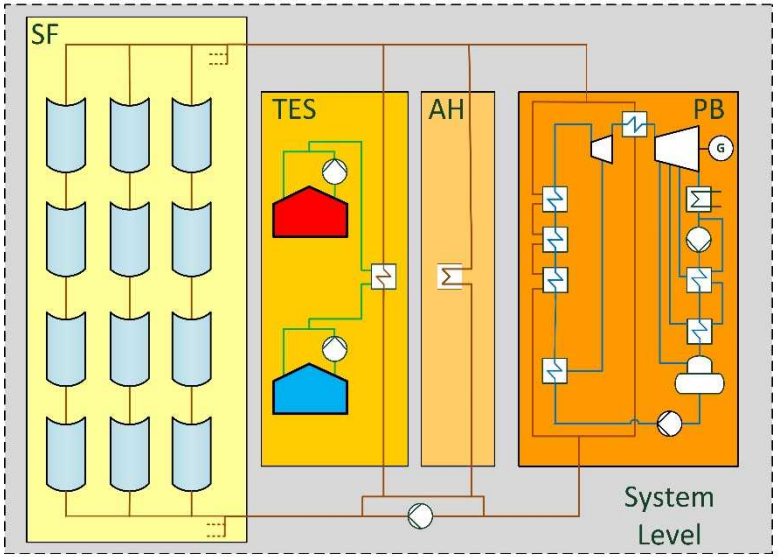
Molten salt thermal energy systems include:

- the storage medium and associated storage vessels
- Circulation pumps, piping, and heat exchangers that are in contact with molten salt.



Molten-Salt Power Tower SubSystems:
SF = Solar Field
AH = Auxiliary Heater
TES = Thermal Energy Storage
PB = Power Block
Blue dashed box indicates the systems covered in this guideline.
Graphic courtesy SolarPACES Guideline for Bankable STE Yield Assessment

TES for a CSP Tower System



Parabolic Trough Plant SubSystems:
SF = Solar Field
AH = Auxiliary Heater
TES = Thermal Energy Storage
PB = Power Block
Graphic courtesy SolarPACES Guideline for Bankable STE Yield Assessment

TES for Parabolic Trough Plant

DEVELOPMENT

TES-1 Outline

Outline

Chapter 1 Scope, Definitions and References

Chapter 2 Planning and Design

Chapter 3 Construction, Installation, and Commissioning

Chapter 4 Inspection, Operation, and Maintenance

Chapter 5 Decommissioning

Considerations

Topics for Consideration:

- Safety and environmental compliance
- Selection of materials
- Handling of materials
- Personnel safety

DEVELOPMENT

Status of Committee

- First Draft of the standard has been developed and submitted for public review
- Committee is still accepting membership applications for contributing and full members
- Committee is looking for more input from operating facilities

ASME Standards & Certification

Learn more about ASME Standards & Certification
http://www.asme.org/kb/standards/standards

TES contact: Nicole Gomez
gomezn@asme.org

ASME HEADQUARTERS
Two Park Avenue
New York, NY 10016-5990 U.S.A.

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DNV·GL

ENERGY

ENERGY

GRIDSTOR: Recommended Practice on safety, operation and performance of grid-connected energy storage systems

DNVGL-RP-0043

Who we are –
DNV GL Energy: services along the energy value chain

GL Group

KEMA

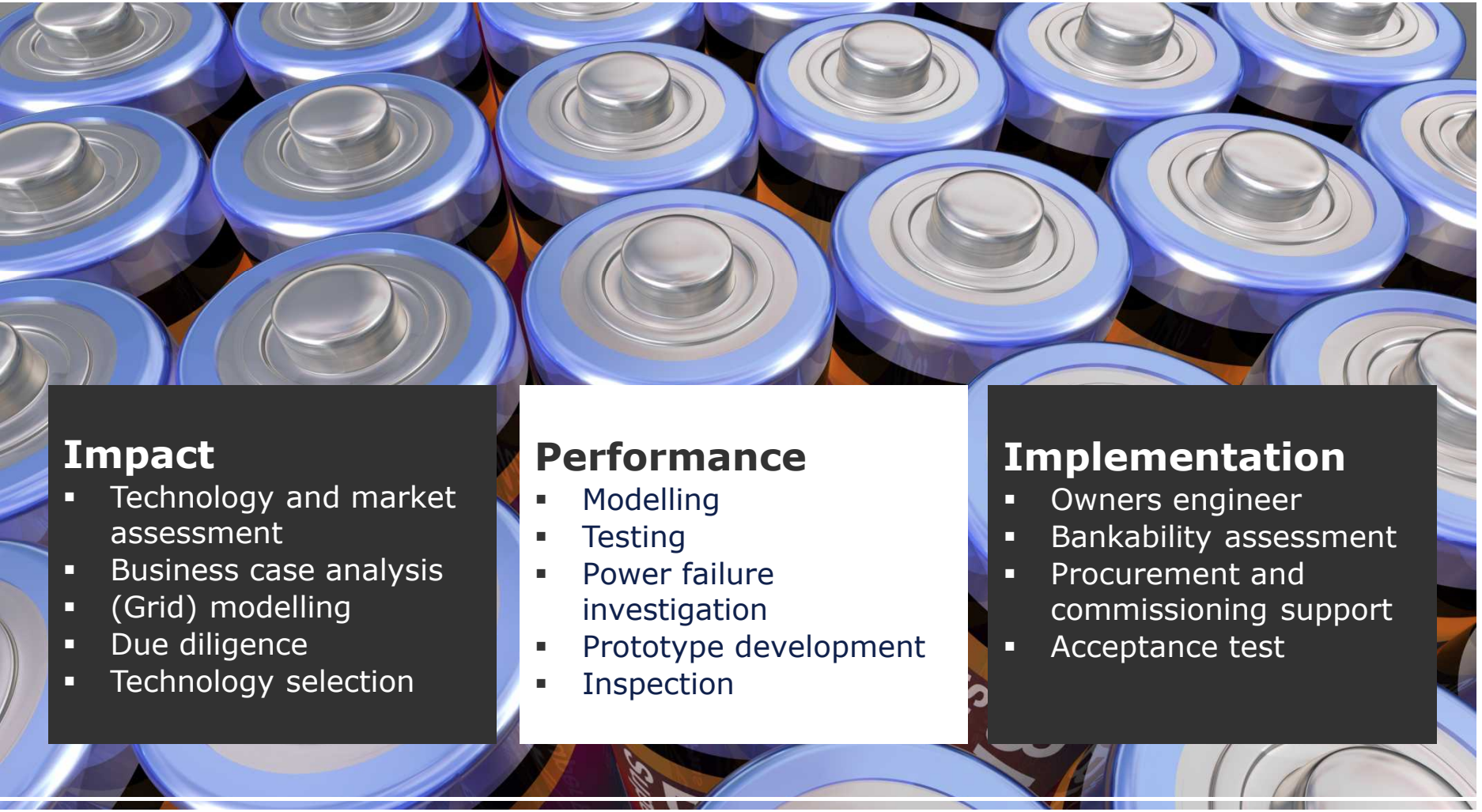
NOBLE DENTON

GARRAD HASSAN

ADVANTICA

DNV·GL

What we do –
DNV GL Energy: Energy storage services



Impact

- Technology and market assessment
- Business case analysis
- (Grid) modelling
- Due diligence
- Technology selection

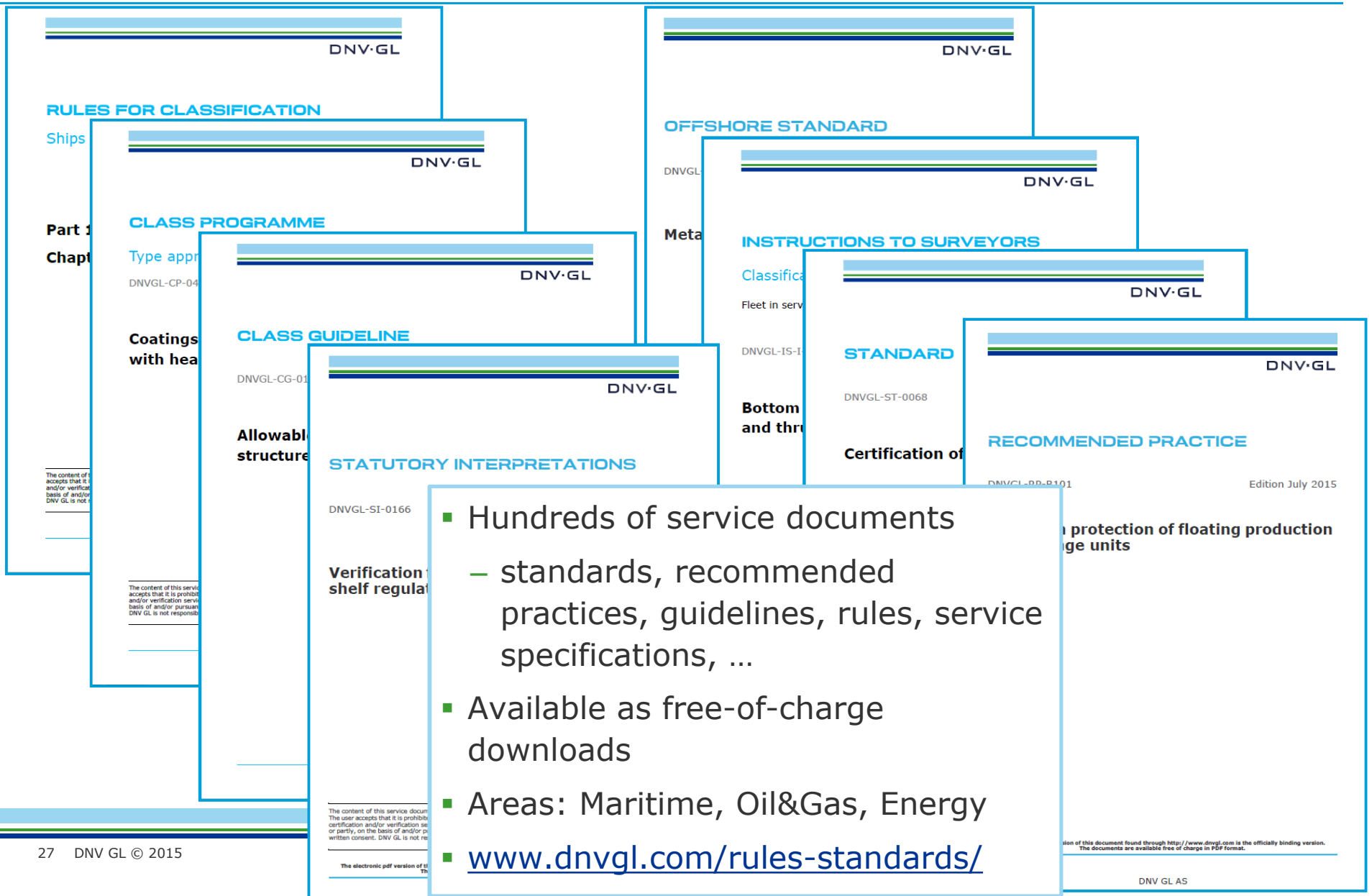
Performance

- Modelling
- Testing
- Power failure investigation
- Prototype development
- Inspection

Implementation

- Owners engineer
- Bankability assessment
- Procurement and commissioning support
- Acceptance test

DNV GL service documents



- Hundreds of service documents
  - standards, recommended practices, guidelines, rules, service specifications, …
- Available as free-of-charge downloads
- Areas: Maritime, Oil&Gas, Energy
- www.dnvgl.com/rules-standards/

DNV GL service document process and governance

- Governance objective: To ensure consistency in the way service documents are governed and managed throughout their life cycle including a clarification of authorities, responsibilities and tasks for key stakeholders involved.

Support and advice internal & external customers

Maintain and develop framework

Joint Industry Projects: creation and review by the industry itself

GRIDSTOR consortiums 2015 + 2017:

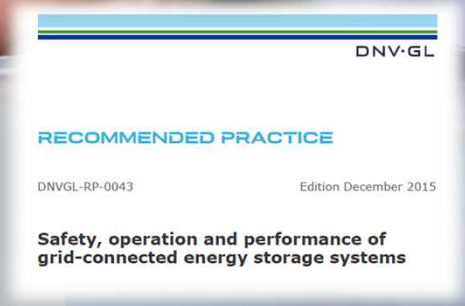
Hearing participants 2015 + 2017

- Alliander
- Clean Energy Council
- Denchi Power
- Ecovat Renewable Energy Technologies
- Electricity Storage Network
- Enel, Ingegneria & Ricerca SpA
- GE Energy Storage
- GNB Industrial Power
- MuGrid analytics
- New York Battery and Energy Storage Technology Consortium (NY-BEST),
- Norton Rose Fulbright LLP
- Scholt Energy Control
- Scottish and Southern Energy Power Distribution (SSEPD)
- UK Power Networks
- Younicos
- ..and 125 other organizations

GRIDSTOR (DNVGL-RP-0043, publ. 2015)

DNV GL issued a Recommended Practice (DNVGL-RP-0043) on **grid-connected energy storage**

- Guidelines and methods to evaluate, assess and test safety, operation and performance of grid-connected energy storage systems
- Referencing ISO, IEC, IEEE, UL etc. standards (197) if possible and relevant, enhancing where needed
- Approach: technology agnostic, specific where necessary; worldwide application



Defining building blocks for an open competitive market place

Continuous updates following technology development and end-user applications

Update published September 2017

GRIDSTOR RP scope and approach

Based on feedback key players

Refined with consortium

Comprehensive

References to existing standards

New content if required

Free to use

SAFETY
FMEA/Bowtie analysis
Risks and mitigation
Design consequences
Procedures & documentation

OPERATION
Monitoring
Control
Grid connection
Environmental analysis

PERFORMANCE
Definitions
Conditions
Measurement
Life cycle costs

APPROACH
System and component level
Technology-agnostic and -specific
Applications and life cycle phases
Standards, guidelines and regulations

GRIDSTOR 2017: updated elements

- Additions / expansions: cyber security, communication protocols, microgrids, conformity assessment incl. FAT/SAT testing, warranty, decommissioning, tendering and procurement, bankability, residual value, greenhouse gas emissions calculation.
- Technology-specific recommendations and background was added on (sub-)technologies: inorganic lithium ion batteries, compressed air energy storage (CAES), liquid air energy storage (LAES), supercapacitors, lead crystal batteries
- Technology-specific safety recommendations for Li-ion batteries were updated
- Recommendations regarding first responders, fire considerations and thermal management were updated
- Overview of normative and informative references was actualised and expanded to include the RP updates described above
- Section 3 was expanded by three applications, previously belonging to other categories: ramp rate control, generation peak shaving, capacity firming
- Section 7 was reorganised for clarity and a more elaborate introduction was added
- Section 10 was turned into Appendix B
- Section 5.2's paragraphs on levelized cost of storage (LCOS) and life cycle costs were moved to the new section 10
- Section B.2 (previously 10.2) was updated and expanded to better reflect the American and European situation
- Various small refinements, corrections and additions were made throughout the RP

Benefits of GRIDSTOR for specific organisations

Utilities and grid service providers

- Independent guideline documents
- Manual for all process phases/aspects
- Confidence in performance as specified

Manufacturers/system integrators

- Proof of quality, reliability, performance
- Distinction from competition

Insurance companies

- Reduced risks by independent and open guidelines based on industry experience

Investors

- Confidence in investment (reduced risks)
- Understanding of technologies and systems

***For all*: up-to-date document, reflecting rapid and recent developments, accelerating the market**

GRIDSTOR: real-life examples of mitigated risks

Feasibility risks

- System dimensioned on minimum CAPEX instead of TCO
- Market saturation not taken into account
- Sub-optimal combination of technology and applications

Performance risks

- Cycle life data under different conditions (DoD, temperature, C-rate)
- Standby losses not taken into account

Contract risks

- Conditions warranty and guarantees unclear
- System boundary unclear – e.g. safety responsibility

Regulation/certification risks

- System specification not in line with market regulation / grid code
- Systems not meeting standardisation

Commissioning risks

- FAT / SAT testing inadequate
- Handover unclear

Safety risks

- Fire suppression for li-ion batteries
- No FMEA analysis, no adequate measures and training
- Cyber safety

Thank you!

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SAFER, SMARTER, GREENER

Data Sheet 5-33,

Electrical Energy Storage Systems

Clinton Marshall

Sr. Staff Engineer

Who is FM Global

- We are an HPR, Mutual insurance company
- Our only focus is property insurance
- Our philosophy is “A majority of all loss is preventable”
- Our method, we utilize engineers to analyze and assess the risks to our client’s facilities, and provide cost effective loss prevention solutions to minimize or eliminate those risks


Engineers 1,812
Serviced Locations 62,218
Engineering Visits/Yr 108,109
Countries Serviced 152

Who is FM Global

- FM Global has different business units, including:
  - Underwriting
  - Engineering,
  - Research,
  - FM Approvals,
  - Training,
  - Staff, etc.
- Engineering Standards

Why are we involved in Li-on ESS?

- Roughly 6 years ago, our clients began asking us for guidance on ESS
- ESS has become more cost effective, with more options for our clients
- We wanted to provide consistent guidance

What is Data Sheet 5-33?

- FM Global's loss prevention guidance for Li-Ion based energy storage systems
- Recommendations cover construction and location, fire protection, electrical system protection and design, operation and maintenance, training, human element, utilities, and contingency planning
- The intent is to ensure limited risk, with an appropriate level of protection, to minimize the impact of a loss on our clients' locations

Li-Ion ESS Timeline

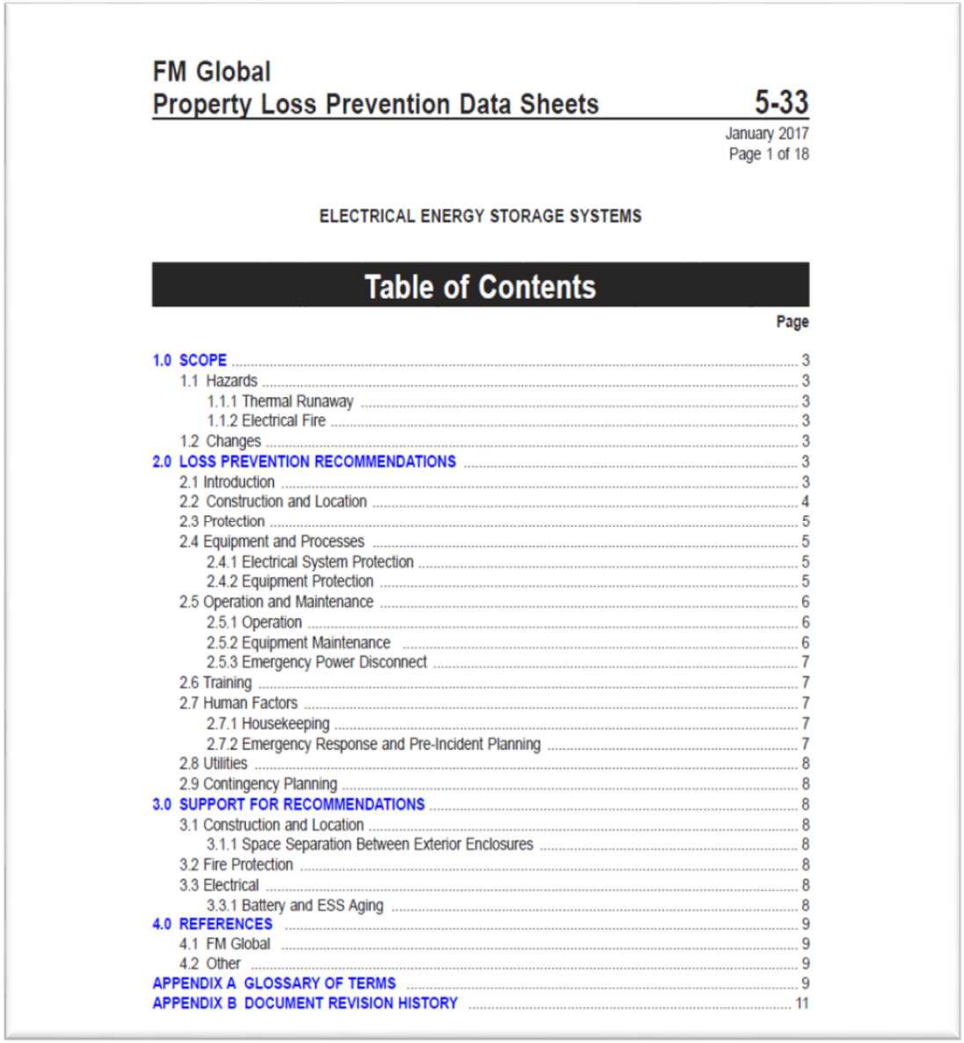
- Late 2016 we started developing DS 5-33, *Electrical Energy Storage Systems*
- Our initial focus was primarily on outdoor units
- Based on a risk assessment of ESS failure modes, to better quantify the risks

DS 5-33

- This document is free to the public at:

  www.fmglobaldatasheets.com

- Register with name, email, organization, job title, and job function



FM Global
Property Loss Prevention Data Sheets 5-33
January 2017
Page 1 of 18

ELECTRICAL ENERGY STORAGE SYSTEMS

Table of Contents

What is next for DS 5-33?

- Revision process starting in 2018, including:
  - Increased focus on fire protection criteria
  - Expanded guidance for indoor installations
  - Guidance for evaluating features of the BMS/SOH
  - Address new technology trends
  - Other applicable issues not addressed previously

FCAC ESS Work Group Update
Evolution of ESS Requirements

Beth Tubbs, FPE

International Code Council

Overview

- 2018 IFC
- 2021 IFC

2018 IFC

- New chapter 12 created – Energy systems
  - Sec. 1203 Emergency and standby power (moved from Chapter 6)
  - Sec. 1204 Solar Photovoltaic Power Systems (moved from chapter 6)
  - Sec. 1205 Stationary Fuel Cell Power Systems (NEW)
  - Sec. 1206 Electrical energy storage systems
    - Battery systems (Moved and heavily revised)
    - Capacitors (NEW)

2018 IFC

- Shift from standby power, emergency power, ups to also include needs for load shedding and load sharing.
- 2015 codes and earlier did not address newer technologies and evolving applications

2018 IFC

- Much of these new sections and revisions came from the work of the Fire Code Action Committee (FCAC)
- Worked with stakeholders such as
  - Telecommunication industry – typically lead acid
  - ESS companies such as Tesla

2018 IFC

- Provisions allow for modifications based on a HRA and full scale fire and fault condition testing
- Array size currently limited to 50 KWh
- Deals with separation requirements as these are no longer stand alone installations in all cases

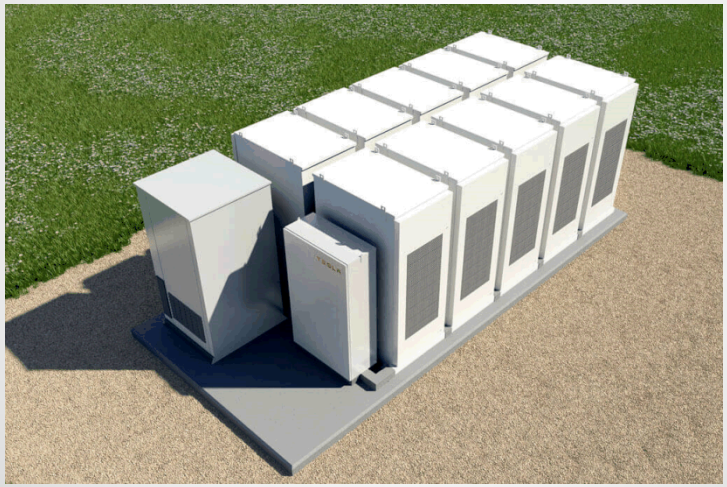
2018 IFC

- Requirements to address new technologies and application

Hazard mitigation analysis

Size/spacing/MAQ limits

UL 9540 Listing



Outdoor installation

BMS

Location in building

Technology specific protection

Exceptions for large scale fire/fault condition testing

2021 IFC

- Some concepts being explored for 2021

Mixed Occupancy Building

Dedicated ESS Building

Outdoors Near Building

Rooftop Installations

Outdoors Remote

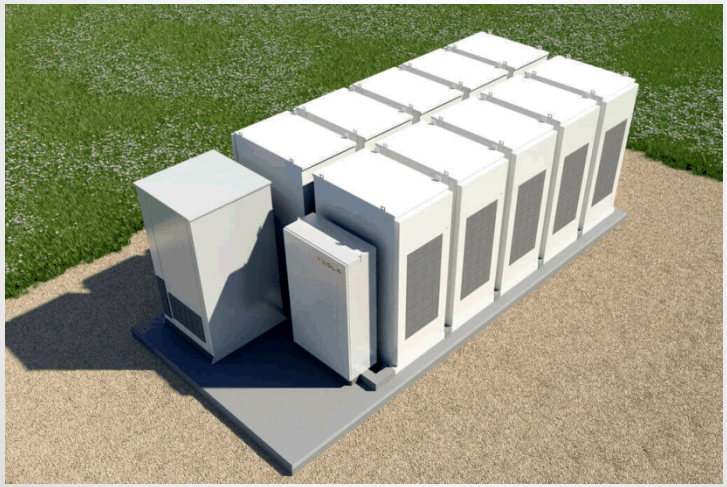
2021 FCAC Code Change Focus Areas

- Being explored by the FCAC ESS work group

Installation scenarios

Review size/spacing/MAQs

Commissioning/ Decommissioning



Exhaust/deflagration venting

Fire propagation tests (UL 9540A)

BMS performance

Evaluate sprinkler effectiveness

Better categorize batteries

Mobile ESS operations

Used Li-ion battery storage

2021 IFC Code Proposal Direction Reorganization of Section 1206 (ESS)

ALL ESS

- 1206.1 General requirements related to permits, construction documents, commissioning, etc.
- 1206.2 Installation and equipment requirements, general items such as listings, electrical connection/protection details, vehicle impact, combustible storage, etc.

Electrochemical ESS (EESS)

- 1206.3 EESS (i.e. battery and capacitor systems).
  - 1206.3.1 – Indoor installations.
  - 1206.3.2 - Outdoor installations.
  - 1206.3.3 – Special installations (Rooftop and open parking garages).
  - 1206.3.4 – Mobile EESS operations
  - (Requirements for these installations are in table format)
- 1206.4 EESS protection that can be provided in the various 1206.3 installations. Protection is selected by the 1206.3 tables. Mix and match!
- 1206.5 EESS technology specific requirements – Protection needed for individual EESS technologies, i.e. spill control not needed if batteries don't have liquid electrolyte.

2021 IFC

- Proposals submitted for IFC in Group A 2018
- These propsoals will be addressed during 2018 and will result in 2021 IFC.
- Schedule is posted on ICC website

Steps in process	Group A	Group B
Deadline for proposals	January 8th (11TH), 2018	January 7, 2019
Proposals Posted	February 28th, 2019	March 4th, 2019
Committee Action Hearing (CAH)	April 15-25, 2018 (Columbus, OH)	April 28-May 8th, 2019 (Albuquerque, NM)
Online Assembly vote	Starts approx. two weeks after last day of the CAH. Open for 2 weeks	
Posting of Committee Action Hearing Results	May 30, 2018	June 11, 2019
Public Comment Deadline	July 16, 2018	July 24, 2019
Posting of Public Comments	August 31, 2018	September 4, 2019
Public Comment Hearings (PCH)	October 24 – 31, 2018 Richmond, VA	October 23-30, 2019 Clark County, NV
Online Governmental Consensus Vote (OGCV)	Starts approx. two weeks after last day of the PCH. Open for 2 weeks.	
Final Action posting	Following Validation Committee certification of OGCV and ICC Board confirmation	

2021 IFC

- Link to IFC Proposals

  https://media.iccsafe.org/codes/2018-2019/GroupA/CAH/IFC.pdf
- Proposals of interest
  - F194-18 through F211-18

Whats next

- Group A schedule as discussed – Hearings in Columbus, Ohio in April and Richmond, Virginia In October
- FCAC will continue to meet and prepare for the hearings
  - March 13-14, 2018
  - June/July, 2018
  - September/October 2018

THANK YOU!

Any questions please email

btubbs@iccsafe.org

National Electrical Contractors Association (NECA)

National Electrical Installation Standards (NEIS)

National Electrical Contractors Association (NECA)

- NECA is the voice of the $130 billion electrical construction industry that brings power, light, and communication technology to buildings and communities across the U.S.

- NECA contractors strive to be solution-providers for their customers, and their industry expertise benefits everyone working on an electrical construction project.

- NECA contractors set industry standards for traditional and integrated electrical systems and lead the industry in the practical application of new technologies.

National Electrical Installation Standards (NEIS)

- National Electrical Installation Standards (NEIS) are a series of quality installation standards for electrical products and systems.
- NEIS extend beyond the minimum installation and safety requirements of the National Electrical Code® (NEC®).
- Address quality and performance aspects of electrical construction.

National Electrical Installation Standards (NEIS)

- National Electrical Installation Standards are the first quality standards for electrical construction.

- Developed by the National Electrical Contractors Association (NECA) to clearly define the actions needed to perform an installation in a "neat and workmanlike manner", as often referenced in the National Electrical Code (NEC, NFPA-70).

- American National Standards Institute (ANSI) – accredited and developed by consensus with industry involvement, updated per ANSI Revision cycles.

National Electrical Installation Standards (NEIS)

- National Electrical Installation Standards provide additional quality and training for electricians and contractors.

- NEIS are used by contractors, consulting engineers, facility managers and electrical inspectors.

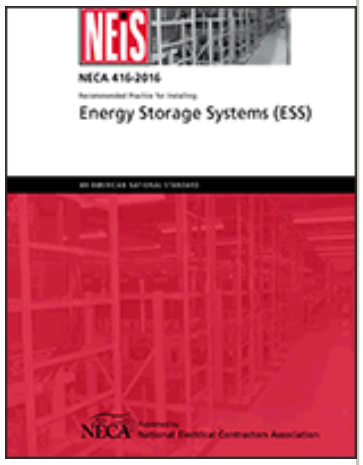
- NECA Flagship NEIS Standard is NECA 1 – 2015, Standard for Good Workmanship in Electrical Construction

NECA 416-2016
Recommended Practice for Installing Energy Storage Systems (ESS)

- NECA 416-2016 is an ANSI-accredited National Electrical Installation Standard for Installing Energy Storage Systems.

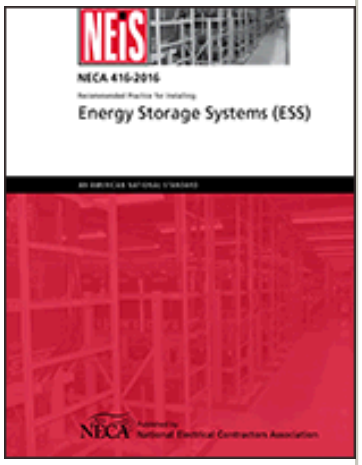
- NECA 416-2016 describes methods and procedures used for installing multiple types energy storage systems.

- NECA 416-2016 also includes information about controlling and managing energy storage systems, in addition to commissioning and maintaining energy storage systems.



NECA 417-201X
Recommended Practice for Designing, Installing, Maintaining, and Operating Micro-grids

- NECA 417-201X will cover the design, installation, maintenance and operation of micro-grids.
- NECA 417-201X the intention would be to include appropriate checklists for installers and inspection jurisdictions for consistency.
- First draft was developed for industry review open for comment until February 2, 2018.
- NECA staff are compiling the comments received.
- Goal is to complete NECA 417-201X by mid-2018.



National Electrical Installation Standards (NEIS)

- Other Related NEIS Standards available from NECA
  - NECA 1-2015, Standard for Good Workmanship in Electrical Construction (ANSI)
  - NECA 90-2015, Recommended practice for Commissioning Building Electrical Systems (ANSI)
  - NECA 100-2013, Symbols for Electrical Construction Drawings (ANSI)
  - NECA 701-2013, Standard for Energy Management, Demand Response and Energy Solutions (ANSI)

Standards Update

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Manager, Global Energy Storage
CSA Group

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Independence, Ohio 44131

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C 202 807 9316

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www.csagroup.org

Power Conversion Equipment

CSA C22.2 No 107.1-2016, Power Conversion Equipment

- Applies to ac and dc type power conversion equipment, which can be associated with an ESS
- 4th Edition of the standard, last issued in 2016
- Under continuous maintenance and will be updated as warranted
- Bi-national via C

Energy Storage Systems

UL 9540, Standard for Energy Storage Systems and Equipment

- Bi-national in US and Canada
- Product certification and Field Evaluation/Special Inspection possible
- In Ontario, June 9th memo from Electrical Safety Authority (ESA) provides the following direction:
  - “Field evaluation agencies performing an inspection on an Energy Storage System shall refer to CAN/ANSI/UL 9540-16 and ensure that the additional requirements from this standard have been addressed and complied with during evaluation.”

Compliance by Market Segment

Residential

- Systems generally require a certification mark from a NRTL
- IEC developing international standards

Commercial/ Industrial (C/I)

- Local AHJ dictates requirements
- Components certified
- Field evaluation programs are an option versus full certification

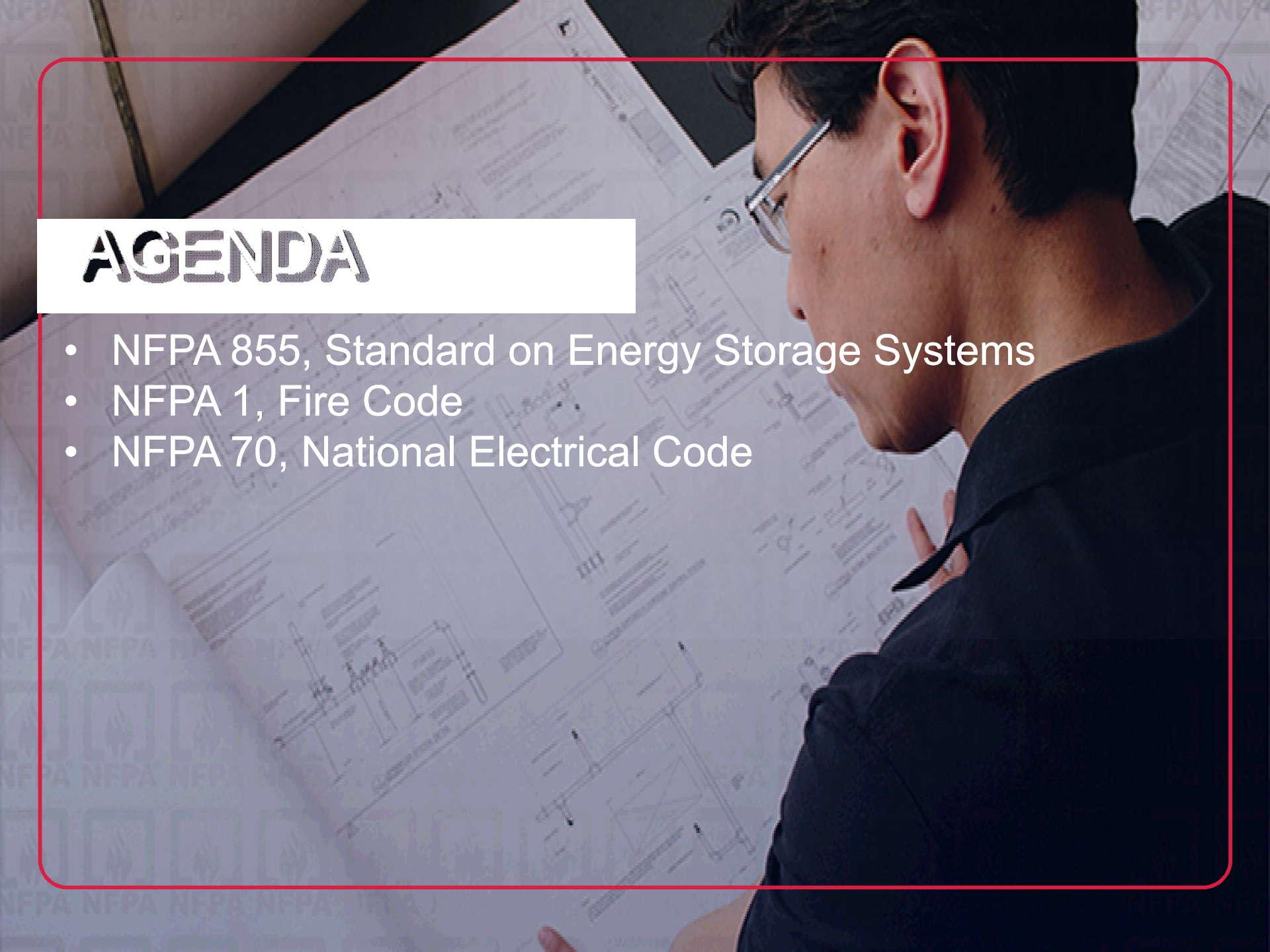
Utility/Community

- Compliance driven by internal safety procedures and AHJ
- Full system standards increasingly popular
- Field evaluation combined with component certification

Energy Storage Codes and Standards

National Fire Protection Association

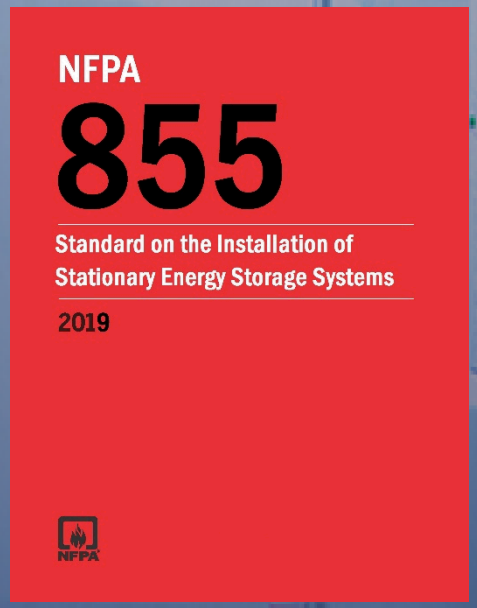
February 7, 2018 | Brian O'Connor | Fire Protection Engineer



AGENDA

- NFPA 855, Standard on Energy Storage Systems
- NFPA 1, Fire Code
- NFPA 70, National Electrical Code

NFPA 855, *Standard on the Installation of Energy Storage Systems*



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NFPA 855 – Development

- April 2016, Project Approved
- August 2016, Committee Formed
- Drafting Meetings
  - January 2017
  - April 2017
  - May 2017
- August 2017 Draft Approved
- First Draft Meetings Oct. 23 & Nov. 27, 2017

NFPA 855 – Schedule

- Public Input Period 4/11/2018 through 6/20/2018
- Second Draft Meeting July 24th – 26th, 2018
  - Salt Lake City
- Publish Date with No NITMAMs - 4/03/2019
- Publish Date with NITMAMs - 8/07/2019

Full Schedule Available @ www.nfpa.org/855

NFPA 855 – Scope

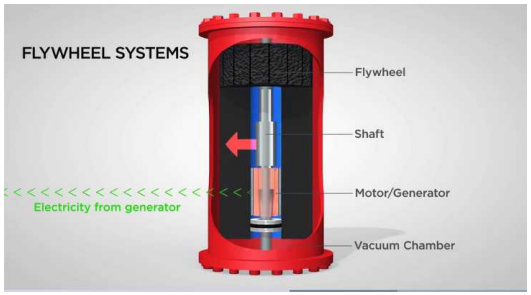
- This standard applies to the:
  - Design
  - Construction
  - Installation
  - Commissioning
  - Operation
  - Maintenance
  - Decommissioning

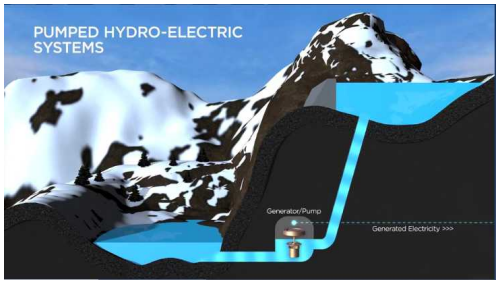
…of stationary ESS.

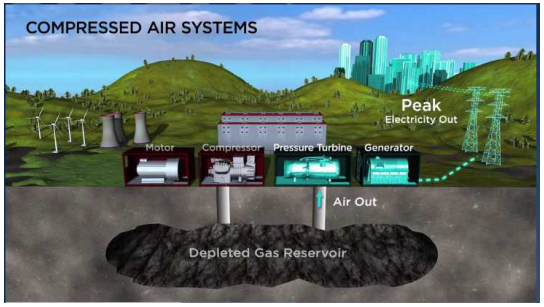
NFPA 855 – Scope

ESS TECHNOLOGY	Aggregate CAPACITY[a]
BATTERY ESS	
Lead acid	70 KWh
Nickel cadmium	70 KWh
Lithium-Ion	20 KWh
Sodium	20 KWh
Flow batteries	20 KWh
Other battery technologies	10 KWh
Batteries in residential occupancies	1 KWh
CAPACITOR ESS	
Capacitors, all types	3 KWh
OTHER ESS	
All other ESS	70 KWh

Types of ESS







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NFPA 855 Chapters

4. General
5. Systems Interconnections
6. Commissioning
7. Operation and Maintenance
8. Decommissioning
9. Electro Chemical ESS
10. Capacitors
11. Fuel Cell ESS

18 One & Two Family Dwellings

NFPA 855 Reserved Chapters

- Chapter 12 Superconducting Magnet ESS (Reserved)
- Chapter 13 Flywheel ESS (Reserved)
- Chapter 14 Humped Hydro ESS(Reserved)
- Chapter 15 Compressed Air ESS (Reserved)
- Chapter 16 Hydrogen ESS (Reserved)
- Chapter 17 Thermal ESS (Reserved)

NFPA 855 - Emergency Planning

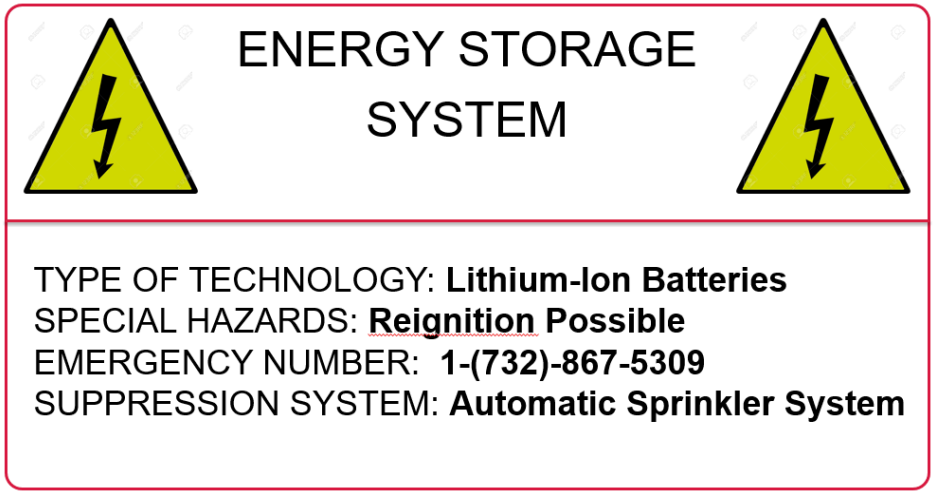
- Emergency Operations Plan
  - Safe shutdown
  - Emergency procedures
  - Response considerations (SDS)
  - Removal of damaged ESS
- Hazard Mitigation Analysis (HMA)
- Fire Mitigation Personnel

NFPA 855 – Equipment

- System listed to UL 9540
- Charge Controllers
- Inverters & Converters
- Energy Storage Management System
- Reused and Repurposed Equipment

NFPA 855 - Electrical Installations

- NFPA 70 or IEEE C2
- ESS Signage
- Separation (Fire Rating)
- Impact Protection
- Security
- Elevation
- Open Rack

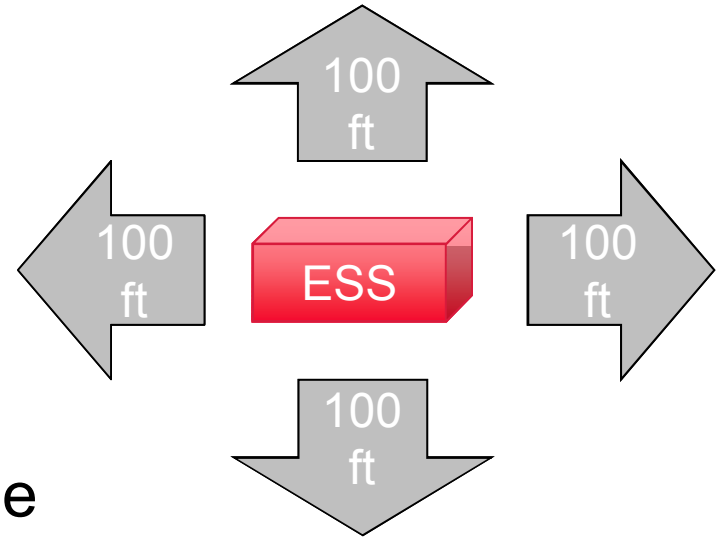


NFPA 855 – Location: Indoors

- Dedicated Use Buildings
- Non-dedicated Use Buildings
- Dwelling and Sleeping Units

NFPA 855 – Location: Outdoors

- Remote
- Near Exposures
- Rooftop & Open Parking Garage



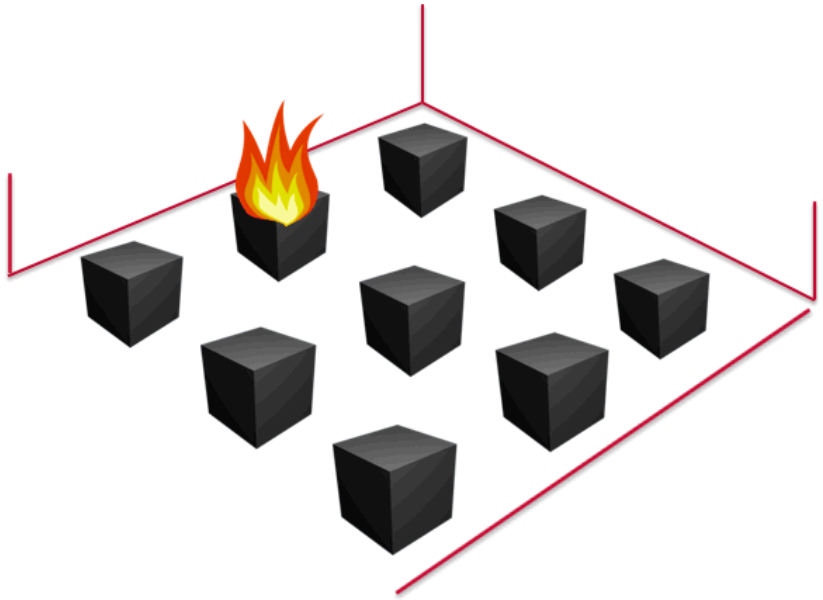
NFPA 855 - Mobile ESS Equipment and Operations

- Charging and Storage
- Deployed

 |

NFPA 855 - Size and Separation

- 250kWh groups
- Spaced 3ft from groups & walls
- Other arrangements based on large scale fire test
- Exempt: Remote Locations



NFPA 855 - Maximum Rated Energy

ESS Type	Maximum Rated Energy* (kWh)
Lead acid batteries, all types[a]	600
Nickel-cadmium batteries (Ni-Cd)[a]	600
Lithium-ion batteries, all types	600
Sodium batteries, all types	600
Flow batteries[†]	600
Capacitors	20
Other battery technologies	200

Exempt: Dedicated use buildings & remote locations

NFPA 855 - Ventilation and Detection

- Ventilation
  - $1ft^3/min/ft^2$
  - Designed to keep flammable gasses under 25% of LFL
  - Exhaust away from openings
  - Gas detection activates ventilation
- Smoke Detection
  - Smoke detection per NFPA 72

Fire Control & Suppression

- Sprinkler System 0.3gpm/ft^2 over 2,500 ft^2
- Other Fire Protection Systems
  - Large Scale Fire Test
  - UL 9540A
- Explosion Control
  - ESS exceeds 25% LFL

NFPA 855 – Annexes(Informational)

Annex B, Energy Storage System Hazards

Annex C, Firefighting Considerations (Operations)

Annex D, Overview of Energy Storage System Technologies

Annex E, Permits, Inspections, Approvals and Connections

NFPA 1 Fire Code

- Chapter 52, Energy Storage Systems
- New to the 2015 edition
- Rewritten in the 2018 edition

NFPA 1, Fire Code (2018) Chapter 52

- Lead Acid & Nickel-Cadmium

Δ Table 52.2.1 Battery Requirements

Requirement	Nonrecombinant Batteries		Recombinant Batteries
	Flooded Lead-Acid	Flooded Nickel-Cadmium (Ni-Cd)	Valve-Regulated Lead–Acid (VRLA)
Safety caps	Venting caps	Venting caps	Self-resealing flame-arresting caps
Thermal runaway management	Not required	Not required	Required
Spill control	Required	Required	Not required
Neutralization	Required	Required	Required
Ventilation	Required	Required	Required
Signage	Required	Required	Required
Seismic control	Required	Required	Required
Fire detection	Required	Required	Required

NFPA 1, Fire Code (2018) Chapter 52

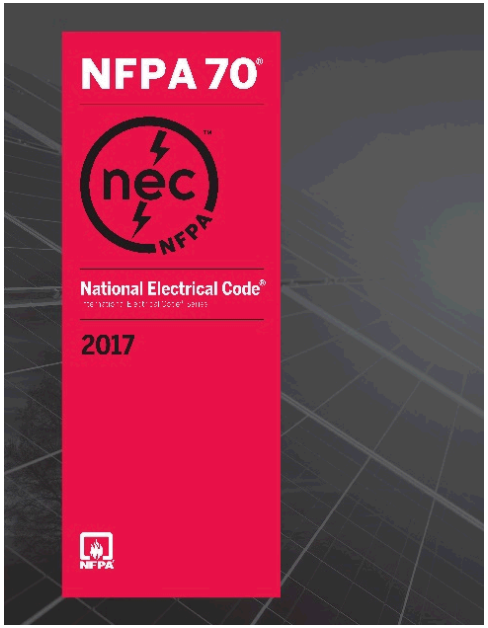
- Location
  - Not above 75ft
  - Not below 30ft
  - Separation from exposures outside
  - Separation by fire walls inside
- Arrays grouped & spaced
- Hazard Mitigation Analysis (HMA)
- Maximum Allowable Quantities (MAQ)

NFPA 1, Fire Code (2018) Chapter 52

- Fire Suppression
  - Per NFPA 13 or
  - Large Scale Testing
- Smoke Detection
  - Per NFPA 72
- Ventilation
  - $1 ft^3/min/ft^2$ or
  - 25% LFL

NFPA 70 Article 706

- Circuit Requirements
  - Overcharge protection
  - Charge Control
- Equipment need to be listed
- Disconnecting means
- Connection to other energy sources
- Location & Ventilation



Questions?

More Information:

www.NFPA.org/855

Brian O'Connor:
BOConnor@NFPA.org

DOE OE Energy Storage Program - Codes and Standards Update

UPDATE ON UL STANDARD ACTIVITY RELATED TO ENERGY STORAGE SYSTEMS

Laurie Florence

March 13, 2018

AGENDA

UL Standards Activity:

- UL 9540
- UL 1973
- UL 1974
- UL 1741
- UL 9540A
- Other UL Related Standards

UL 9540 OVERVIEW

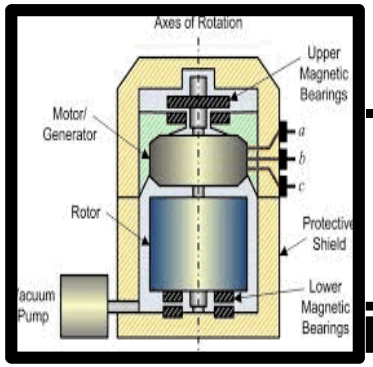
Energy Storage Systems and Equipment

- Safety Standard
- Includes energy storage systems that are
  - Standalone to provide energy for local loads;
  - In parallel with an electric power system, electric utility grid; or
  - Able to perform multiple operationa
  - For use in utility-interactive applica compliance with IE 1547.1 or
  - Other applications i support functionalit
  - May include balanc plant and other ancillary equipment of the system

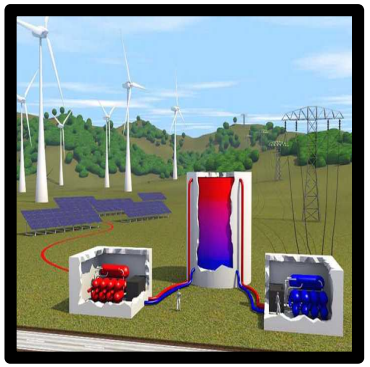
UL 9540 OVERVIEW

Types of Energy Storage Technologies within Scope of UL 9540

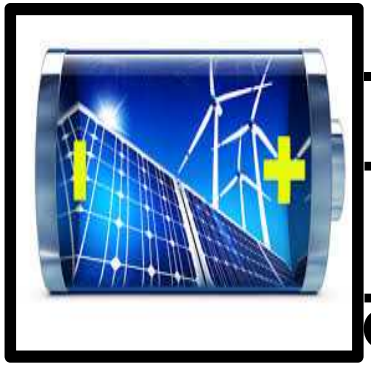
Mechanical



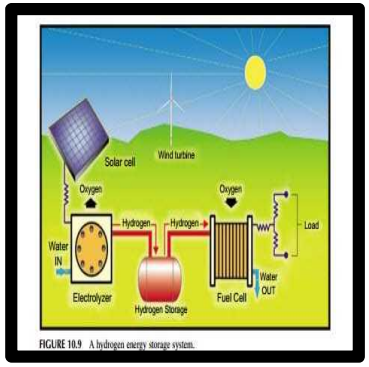
Thermal



Electrochemical



Chemical



UL 9540 OVERVIEW

Some Proposed changes:

From 1 year of use and updates/developments in codes

- Clarification of scope
- Clarification of mechanical test methods
- Modification of ISO containers/impact on strength
- Addition of grounding connections details
- Reference to new fire code criteria with regard to fire detection and suppression

UL 9540 OVERVIEW

Significant Dates in The UL 9540 Timeline

- UL Subject 9540 Published
  - Non consensus standard
- Referenced in 2017 NEC
- ANSI/CAN/UL 9540 published
  - Bi-national consensus standard for the USA and Canada
- Proposals submitted for
- 2nd edition (2018)
- Referenced in 2nd Draft of NFPA 855, (2018)

UL 1973 OVERVIEW

UL 1973, Batteries for use in Light Electric Rail (LER) and Stationary Applications

Scope

- Safety standard for Cells, Modules and Battery Systems
- Non technology specific and includes specific criteria for
  - Lithium ion
  - Nickel
  - Lead Acid
  - Sodium Beta
  - Flow Batteries
  - Electrochemical Capacitors (*ultraca*

- Construction & Testing (type and routine) Criteria

UL 1973 OVERVIEW

- Revisions within 2nd edition of UL 1973
- Include Canadian requirements (for bi-national standard)
- Revisions to the internal fire test
  - Renamed to single cell failure tolerance test
- Include arc flash calculation information in instructions
- Short circuit current rating and check value during short circuit test
- Change terminology throughout standard (change from “energy storage system” to “battery system”
- Add production quality control

UL 1973 OVERVIEW

Significant Dates in The UL 1973 Timeline

- UL Subject 1973Published
  - Non consensus standard
- ANSI/UL 1973 published
  - Consensus standard for the USA
- Referenced in 2017 NEC
- Published 2nd edition
  - Bi-national standard for USA and Canada

UL 1974 OVERVIEW

UL 1974, Standard for Evaluation for Repurposing Batteries

Scope:

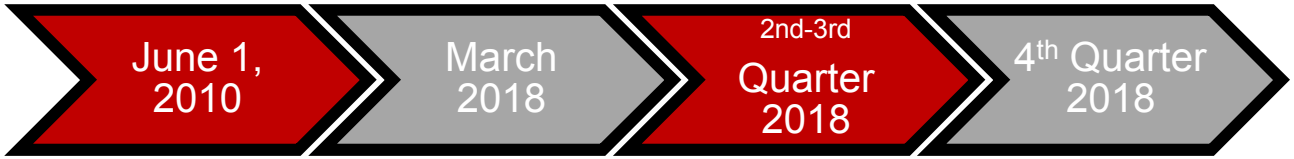
- covers the sorting and grading process of battery packs, modules and cells that were originally configured and used for other purposes, such as electric vehicle propulsion, and that are intended for a repurposed use application, such as for use in stationary energy storage and other applications.
- The process of sorting and grading these devices is essentially determining the state of health and other parameters to identify continued viability and the rating mechanisms the manufacturer may use for those that are determined suitable for continued use.

UL 1974 OVERVIEW

- UL 1974 is a “manufacturing process” standard that looks at the methods used to determine safety and performance of batteries, modules and cells from used EV battery systems (i.e. repurposing process)
- Assembled batteries need to meet the end product when re-assembled into a 2nd use battery
  - UL 1973 for stationary batteries

UL 1974 OVERVIEW

Significant Dates in The UL 1974 Timeline



- UL Subject 1974 bulletin out for review
- UL Subject 1974 Ballot out for review and voting
- UL 1974 Recirculation Bulletin out for review and voting
- 1st edition UL 1974 published
- Bi-national standard for USA and Canada

UL 9540A, LARGE SCALE FIRE TEST METHOD

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

Developed to address requirements in codes (e.g. ICC IFR and NFPA 855) for large scale fire testing

- Required for various indoor and other installations to avoid limitations on size of battery energy storage systems, reduce spacings between individual systems and walls, lower sprinkler density, etc.
  - Multiple parts:
  - Cell Level
  - Module Level
  - Unit Level
  - Installation Level

UL 9540A, LARGE SCALE FIRE TEST METHOD

Several Levels of Testing:

Cell Level – fail cells through various methods & gather information

Module Level – fail cells in modules and gather information

Unit Level – Conduct testing at unit level with repeat of cell failure in one of the modules in initiating unit and surround with target units

Installation Level – Repeat of Unit level test within test room with sprinkler systems or other protection mechanisms and overhead cabling

UL 9540A OVERVIEW

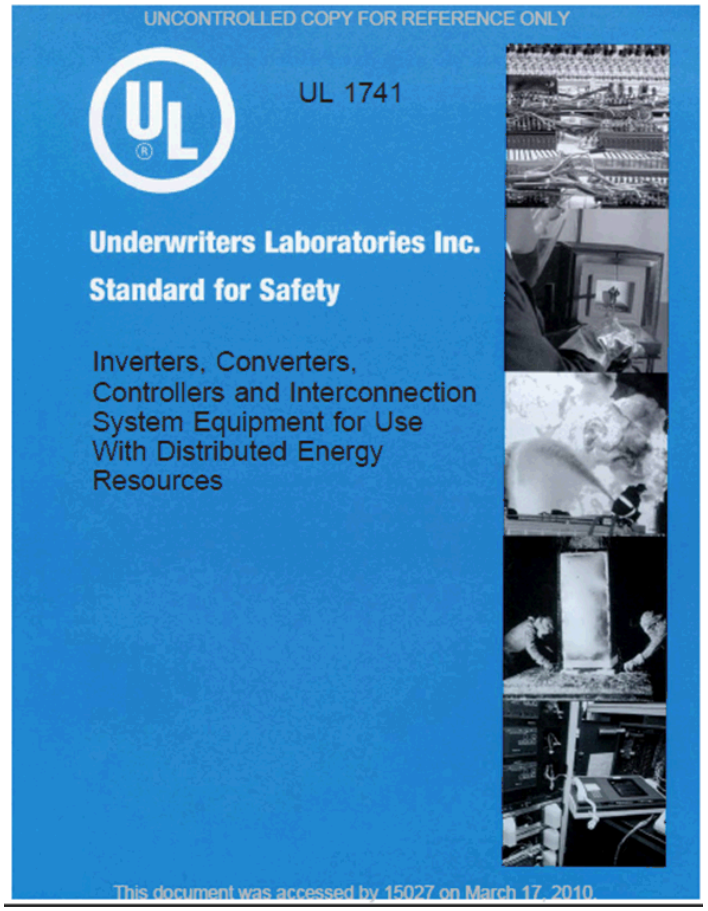
Significant Dates in The UL 9540A Timeline

- UL 9540A Test Method published
- 2nd Edition published
- Proposed reference in NFPA 855 2nd draft and next revision of ICC IFC
- Begin consensus process within UL 9540 STP

UL 1741 OVERVIEW

UL 1741 Covers Power Conversion and Protection Equipment for the Following Types of DR products:

- •Photovoltaics, PV
- •Fuel Cells
- •Micro-turbines
- •Wind and Hydro Turbines
- •Engine Generator Set
- •Utility Interactive Inverters
- •Grid Support Interactive /Smart Inverters
- •Grid Interconnection Systems Equipment
- •Stand Alone Inverters
- •Multi-Mode Inverters
- •AC Modules
- •Charge Controllers
- •PV Balance of Systems,
- •PV Rapid Shutdown equipment
- •Combiner Boxes, GFDIs, etc



UL 1741 OVERVIEW

UL1741 SA - Grid Support Utility Interactive Supplement to “bridge the gap” until the new IEEE 1547 and IEEE 1547.1 Grid Support revisions are completed.

Utility-Interactive and Multi-Mode Inverters with Capability to Actively

Need to specify functionality, characteristics and operational parameters.

- Actively limited output real power commanded or scheduled.
- Communications protocol, means and response characteristics.
- Time schedule with specified response characteristics.
- Power output changes with respect to generation limits.
- Power output changes in response to abnormal

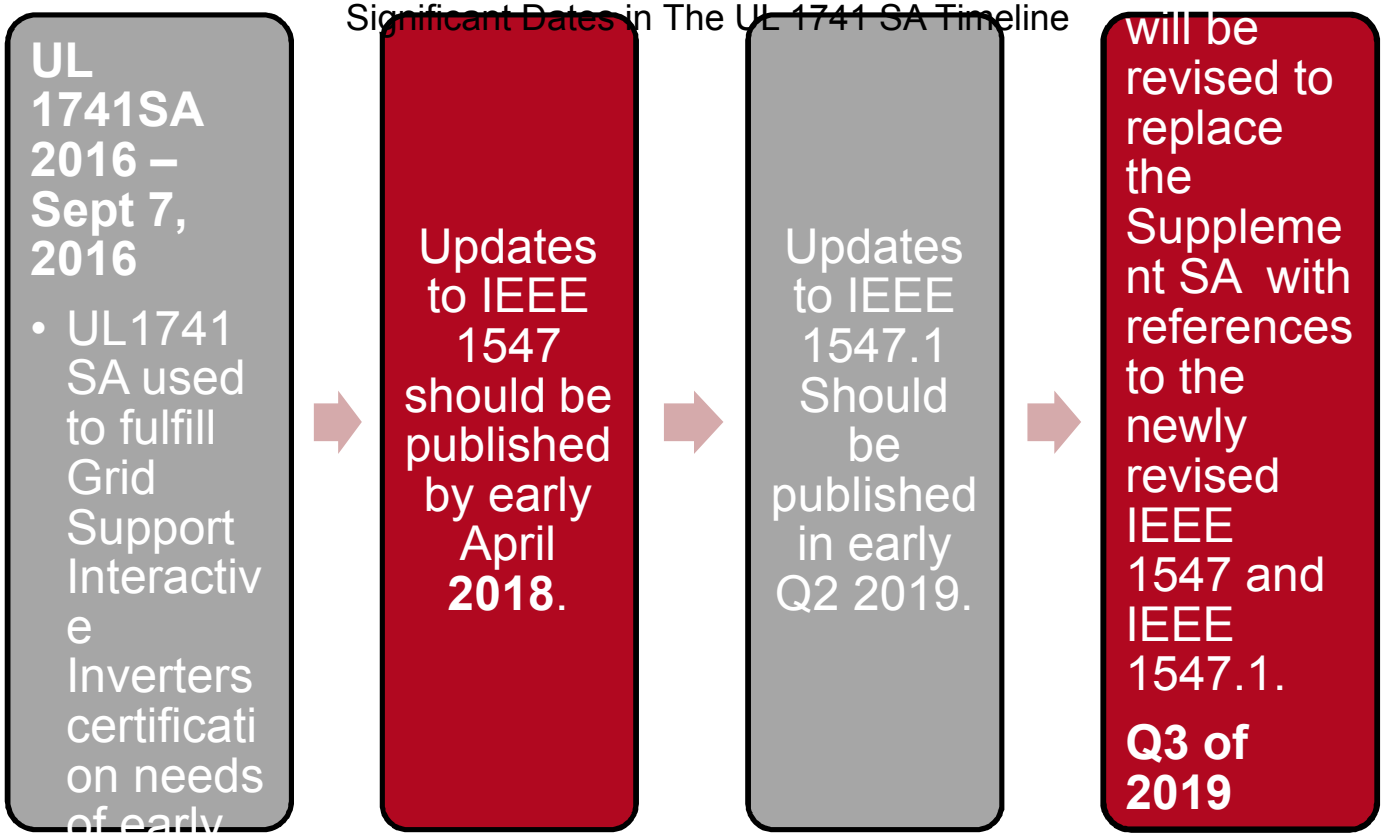
Need to Differentiate Utility Interactive Products

Utility Interactive	Grid Support Utility Interactive	Special Purpose Utility Interactive
Traditional UL1741 IEEE 1547 & 1547.1 Interconnection Requirements	UL 1741 SA Grid Support Functions	Specific Mfr / Utility Defined UL Verified Compliance

- The above categories clearly define product functions and ratings per the product's markings, ratings, manual, and certification documentation.

UL 1741 OVERVIEW

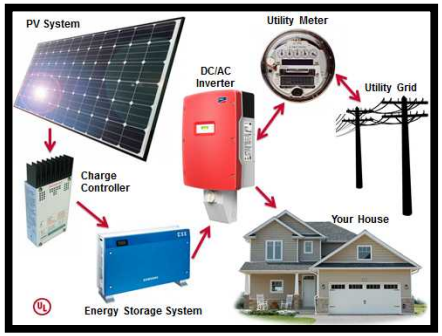
Significant Dates in The UL 1741 SA Timeline



OTHER UL STANDARDS DEVELOPMENT

UL 3001, Distributed Energy Generation and Storage Systems

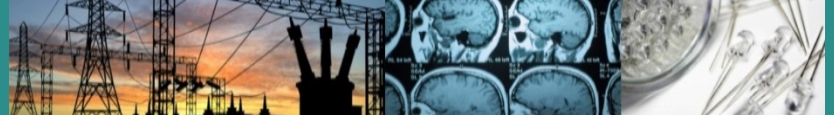
- Scope: Safety of a distributed generation system with storage
- Status:
  - STP established
  - First edition bulletin under development



UL 9540A, Thermal Runaway Fire Propagation within Battery Energy Storage Systems

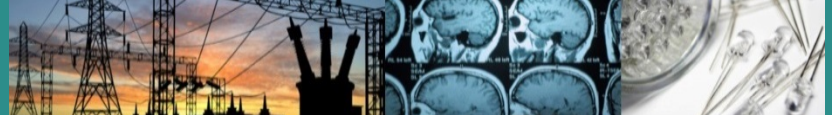
- provide fire test data and acceptance thresholds
  - to meet fire safety objectives included in the model fire and other codes (*large scale fault and fire testing*).

FIND US ON…



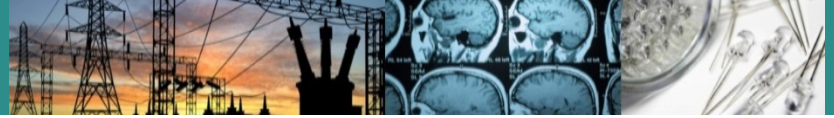
Energy Storage Section Updates and IEC Technical Committee Support

March 13, 2018



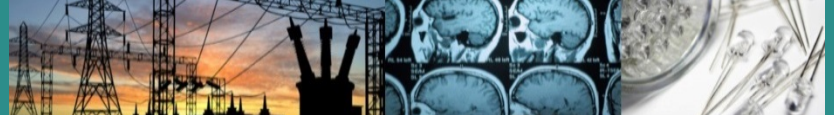
NEMA ESS Section Scope

- Includes
  - Storage device/medium
  - Power conversion systems
  - Control & management systems
  - Up to point of common coupling with a grid or premise
- Grid connected or independent of the grid
- Operator (utility) side or consumer side of the electric power system



NEMA ESS Section Activities

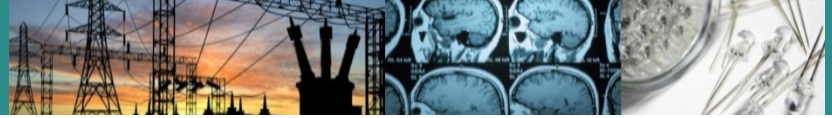
- Lead ANSI Energy Storage Systems Accredited Standards Committee and publish PNNL Protocol as an ANSI/NEMA standard
- Serve as secretariat for IEC TC 120
- Lead NEMA member public inputs on related ES codes and standards
  - NEC 706
  - NFPA 855
  - International Code Council proposals to 2021 Group A codes



ANSI/NEMA Standard on ESS

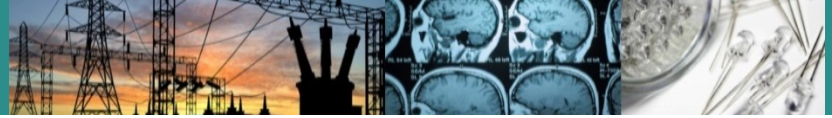
- Initiated ANSI/NEMA process to develop a ESS standard based on the PNNL/SNL protocol.
- Focus is on electrical energy storage systems
- Developed a consensus body with appropriate balance
- Provides a set of “best practices” for characterizing ESS and measuring and reporting their performance
- Serves as a basis for assessing how an ESS will perform with respect to key performance attributes relevant to different applications
- Provides a valid and accurate basis for the comparison of different ESSs
- Enables more informed decision-making in the selection of ESSs for various stationary applications

Balloting as a NEMA Standard – May 2018 anticipated published date



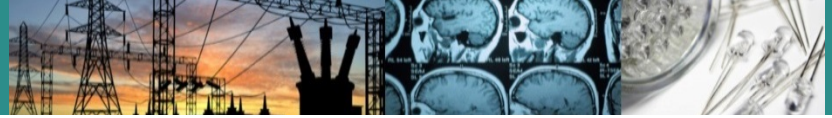
Canvass Process

- Establish Consensus Body
- NEMA (Section, Counsel and C&S) Approve Project
- Submit PINS to ANSI
- Develop Document as an ANS
- Announce in ANSI Standards Action
- Ballot Draft to Consensus Body
- Resolve Comments
- Recirculate Unresolved Comments & Votes to Consensus body
- Edit final draft
- Approval by ANSI
- Submit Documentation to ANSI - BSR-9
- Publish standard as ANS



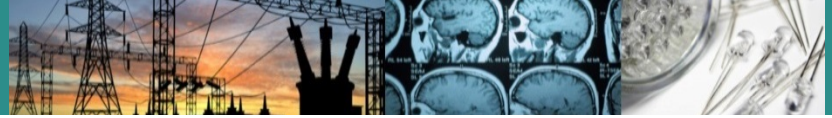
IEC Technical Committee 120

- Standardization in the field of grid integrated EES systems. Focuses on:
  - Energy storage systems rather than devices.
  - Interaction between EES Systems and electric power systems
  - system aspects and the need for new standards for EES systems.
- Safety requirements for grid integrated EES systems electrochemical based systems
- The US Technical Advisory Group welcomes new members!



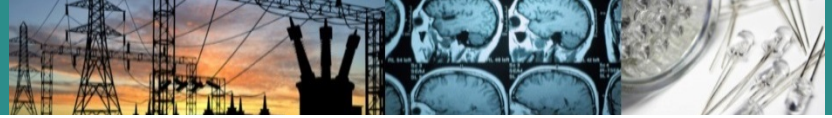
Examples of IEC TC 120 Standards

IEC number	Description	Status
62932-2-2	Flow battery systems for stationary applications- Part 2-2: Safety requirements	Committee Draft for Vote due 3/16/18
62933-5-1	EES systems – Part 5-1: Safety considerations related to grid integrated EES systems	Published
62933-5-2	EES systems - Part 5-2: Safety considerations related to grid integrated EES systems - batteries	Committee Draft comments due 3/30/18
62984-3-1	High Temperature Secondary Batteries, Part 3 Sodium-based batteries, Section 1 Safety requirements and tests	Committee Draft released 12/8/17
62485-5	Safety requirements for secondary batteries and battery installations - Part - 5: Lithium-ion batteries for stationary applications	Committee Draft released 1/5/18



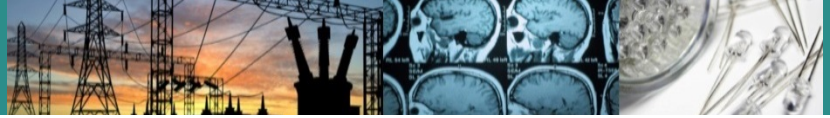
IEC 62933-5-2 (Batteries)

- BESS can be integrated in virtually all types of grids
- The safety culture of stakeholders (integrators, operators and end-users) of such systems may vary from a high level to nearly full ignorance
- BESS are complex at the systems level due to the variety of potential battery options and configurations including the combining subsystems
- Compliance with standards and related material produced specifically for the safety of subsystems does not ensure absolute intrinsic safety of the overall system
- BESS may have additional safety hazards due to chemicals, for example



IEC 62933-5-2 Battery Chemistry Categories

Group A	BESS using non-aqueous electrolyte battery (e.g. Li-based)
Group B	BESS using aqueous electrolyte battery (e.g. Lead acid, Ni-based)
Group C	BESS using high temperature battery (e.g. NaS, NaNiCl)
Group D	BESS using flow battery
Group E	Others (ex: chemical based supercapacitors)



Thank you.

Contact Info:
Steve.Griffith@nema.org
Brian.Marchionini@nema.org

The Role of IEEE in Safety Codes and Standards Efforts

Background on IEEE

- IEEE is made up of a number of Societies with over 423,000 members in over 160 countries.
- The Power and Energy Society is now the largest society with > 40,000 members.
- Its emphasis is on several areas of technical focus:
  1. Development of technical standards that are considered best practices, guides and background for many commercial standards.
  2. Highly sited publications
  3. Technical conferences around the world
  4. Professional and Educational activities
- Recognized as the trusted voice for engineering, computing and technology information.

IEEE SCC18 & ESSB Committee Safety Code Efforts

Christel Hunter, SCC18 Chair

Chris Searles, IEEE Energy Storage & Stationary Battery (ESSB) Committee Chair

Bill Cantor, ESSB Safety Codes & Standards WG Chair

Who are IEEE SCC 18 and IEEE ESSB and What do they do?

- **IEEE SCC 18** is responsible for coordinating and establishing the IEEE position on certain National Fire Protection Association (NFPA) technical committees.

- **IEEE ESSB** represents the IEEE on various National Fire Protection Association (NFPA)Technical Committees but is not restricted to just NFPA issues:
  - **NFPA 70 – *National Electrical Code***
    - ✓ ***Bill Cantor – ESSB WG Chair/NEC 70-CMP 13 [Batteries]***
  - **NFPA 70B – *Recommended Practice for Electrical Equipment Maintenance***
    - ✓ ***Bill Cantor – ESSBWG Chair/Primary Rep [Electrical Maintenance]***
  - **NFPA 855 – *Standard for the Installation of Stationary Energy Storage Systems***
    - ✓ ***Bill Cantor – ESSBWG Chair/Nominated as IEEE Representative***

- **SCC 18** Membership is open to those who are:
  - IEEE members above student grade, and
  - Standards Association (SA) members, and
  - Sponsored by an IEEE society, department, committee or subcommittee

- **SCC18** members come from…
  - Electrical Safety Committee: 2
  - Industrial &Commercial Power Systems Dept.: 13
  - Petroleum & Chemical Industry Committee: 8
  - Power & Energy Society: 4
  - Computer Engineering Society: 2

- **Name: Standards Coordinating Committee 18**
- Reports to: IEEE Standards Association
- Type of Committee: 1 (does not write standards)
- Leadership:
  - Chris Hunter, Chair
  - Dennis Nielsen, Vice Chair
  - Paul Myers, Secretary/Treasurer
  - Arthur Smith, Elections Officer
  - Bill McCoy, Membership Officer
  - Mario Spina, Webmaster
  - Ed Larsen, Past Chair
  - **Staff liaison: Pat Roder**

- **Name: IEEE Energy Storage & Stationary Battery Committee**
- **Reports to: IEEE Power and Energy Society Technical Committee**
- **Type: 2 (does write standards)**
- **Leadership:**
  - Chris Searles, Chair
  - Curtis Ashton, Vice Chair
  - Babu Chalamala, Secretary
  - Tom Carpenter, Treasurer
  - Jim McDowall, Standards Coordinator
  - Paul Hectors, Webmaster
  - Rick Tressler, Past Chair
  - Kurt Uhlir, SBEE Subcommittee
  - Steve Vechy, DCRS Subcommittee
  - **Staff liaison: Michael Kipness**

What is the IEEE ESSB Safety Codes and Working Group Attempting to do?

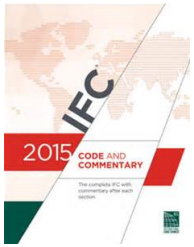
IEEE

CURRENT ESSB COMMITTEE STANDARDS ADDRESSING SAFETY ISSUES/CONCERNS

Standard	Description	Standard	Description
IEEE 450	Maintenance & Testing VLA's	IEEE 1657	Qualifications for Installation/ Maintenance Technicians
IEEE 1188	Maintenance & Testing VRLA's	IEEE 1679	Characterization/Evaluation of Emerging Technologies
IEEE 1375	Protection of Stationary Batteries	IEEE 1679.1	Characterization & Evaluation of Lithium-Based Batteries
IEEE 1578	Spill Containment & Management	IEEE 1679.2	Characterization & Evaluation of Sodium-Based Batteries
IEEE 1635	Ventilation & Thermal Management of SB's	To be Proposed	Characterization & Evaluation of Flow-Based Batteries

IEEE

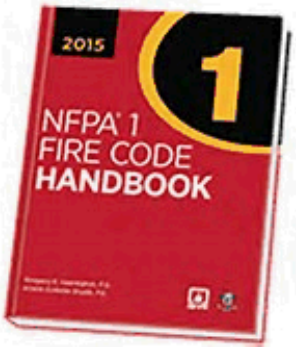
Major Fire/Building Codes that Include Stationary Battery Regulations



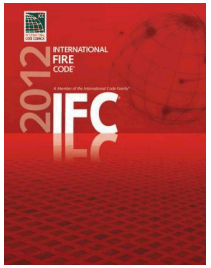
New Battery Section in 2018 Edition

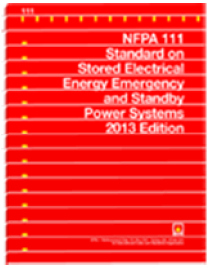
2021 Battery Section Already Drafted! - FCAC

New!
NFPA 855
1st DRAFT DONE
2nd DRAFT



New Battery Section in 2018 Edition





Driver for Fire Code Battery Section Changes

Unknown (or unfamiliar with) hazards with new technology battery systems.

New deployment applications such as micro-grids

Density of energy storage in residential complexes and high rise buildings!

Parallel Code Development Tracks

NFPA-1 2021

- **TO**: Technical Committee on Fire Code
- **FROM**: Kristin Bigda, *Staff Liaison*
- **DATE**: January 12, 2018
- **SUBJECT**: SAVE THE DATE - NFPA 1 Pre-First Draft TC Meeting (A2020)
- **Date:** May 30-31, 2018
- **Meeting Location:** To be determined

Process Stage	Process Step	Date	Year
Pre-First Draft	Technical Committee Meeting	30-31-May	2018
First Draft	Public Input Closing Date	27-Jun	2018
	First Draft Report Posting Date	27-Feb	2019
Second Draft	Public Comment Closing Date	8-May	2019
	Second Draft Report Posting Date	22-Jan	2020
Motions Committee Report (NITMAM)	NITMAM Closing Date	19-Feb	2020

NFPA-855-2020

rocess Stage	Process Step	Date	Year
irst Draft	First Draft Posting and Technical Committee Ballot	24-Jan	2018
	Final Date for Receipt of Technical Committee First Draft Ballot	7-Feb	2018
	Final Date for Receipt of Technical Committee First Draft Ballot - Recirculated	14-Feb	2018
	First Draft Report Posting Date for Public Comment	11-Apr	2018
	Public Comment Closing Date	20-Jun	2018
Second Draft	Second Draft Technical Committee Meeting	15-Aug	2018
	Second Draft Report Posting and Technical Committee Ballot	10-Oct	2018
	Final Date Receipt of Technical Committee Ballot	24-Oct	2018
	Posting of Second Draft	TBD	TBD
	Second Draft Meeting	TBD	TBD
	Second Draft Ballot	TBD	TBD
Motions Committee Report (NITMAM)	Post Second Draft for NITMAM Review	3-Jan	2019
	NITMAM Closing Date	31-Jan	2019
	Posting of NITMAM CAM	3-Apr	2019
	Appeal Closing Date for Consent Standards	18-Apr	2019
	Appeal Closing Date for Standards with CAMS	10-Jul	2019

IFC-2021

Process Step	Date	Year
Deadline for CDP Access Online Receipt of Code Change Proposals	12-Jan	2018
Web Posting of Proposed Changes to the I-Codes	28-Feb	2018
Committee Action Hearing (CAH) in Columbus Ohio	15-Apr - 25-Apr	2018
Committee Action Committee Online Vote for CAH Floor Motions	15-May	2018
Web Posting of Report of CAH	30-May	2018
Deadline for CDP Access Public Comments for CAH Report	16-Jul	2018
Web Posting of Public Comment Agenda	31-Aug	2018
Public Comment Hearing (PCH)	24-Oct - 31-Oct	2018
Online Government Consensus Vote	15-Nov	2018
Web Posting of Final Action	30-Nov	TBD

Code Meeting Schedule

Code	Title	Current Edition	Next Edition
NFPA-1	Fire Code	2018	2021
IFC	International Fire Code	2018	2021 (2021 input was due 12-January 2018)
NFPA-855	Energy Storage Standard "New "	New	2020 (First Draft Posting April 11, 2018)
NFPA-70	National Electrical Code	2017	2020 (First Draft Posting July 6, 2018)
NFPA-101	Life Safety Code	2015	2021
IBC	International Building Code	2018	2021
IMC	International Mechanical Code	2018	2021
NFPA-110/111	Standard on Stored Electrical Energy Emergency and Standby Power Systems	2016	2019 (Jan 24, 2018 Second Draft Posting, Feb 21, 2018 NITMAM deadline)

2018 IFC and NFPA-1 Threshold Quantities

Figure 1. Battery Capacity Threshold Covered by Codes	
Technology	Capacity Threshold (kilowatt hours)
Lead Acid (all types)	70 KWh (252 Mega joules)
Nickel Cadmium (Ni-Cd)	70 KWh (252 Mega joules)
Lithium (all types)	20 KWh (72 Mega joules)
Sodium (all types)	20 KWh (72 Mega joules)
Flow Batteries	20 KWh (72 Mega joules)
Other Battery Technologies	10 KWh (36 Mega joules)

NFPA-855 Threshold 1 KWh for Residential Battery !!!

Kilowatt-hours for a single string (array): rated amp-hours (at an 8-hour rate) multiplied by the battery string voltage and divided by 1000. As an example of a system that is covered by the code, the photograph below shows strings of VLA batteries that are rated at approximately 4000 amp-hours. So even a single string would be subject to the codes. 48V x 4000 amp-hours / 1000 = 192 KWh.

NFPA-111 Standard on Stored Electrical Energy Emergency and Stand-by Power Systems

Guidelines for safe deployment and operation of stationary battery systems in stand-by applications.

- The emergency power systems that operate at less than 24 volts and/or less than 500 VA are not subjected to these requirements.

Not used as basis for existing code enforcement.

Industry best practices for power sources, controls, converters, transfer equipment, and accessory equipment including:

- Installation
- Maintenance
- Operation
- Testing

A sister document NFPA-110 focuses more on generators and associated back-up power.

Proposed 2021 IFC Additions

- Standby power for ventilation
- Operational permits
- More construction documentation
- Decommissioning
- Limit array size to 50 KWh
- Align with NFPA-855
- Residential Battery Code (Chapter 18)
- More full scale fire testing
- Listing to UL9540
- Larger outdoor separation distances

2018 Stationary Battery Section Changes

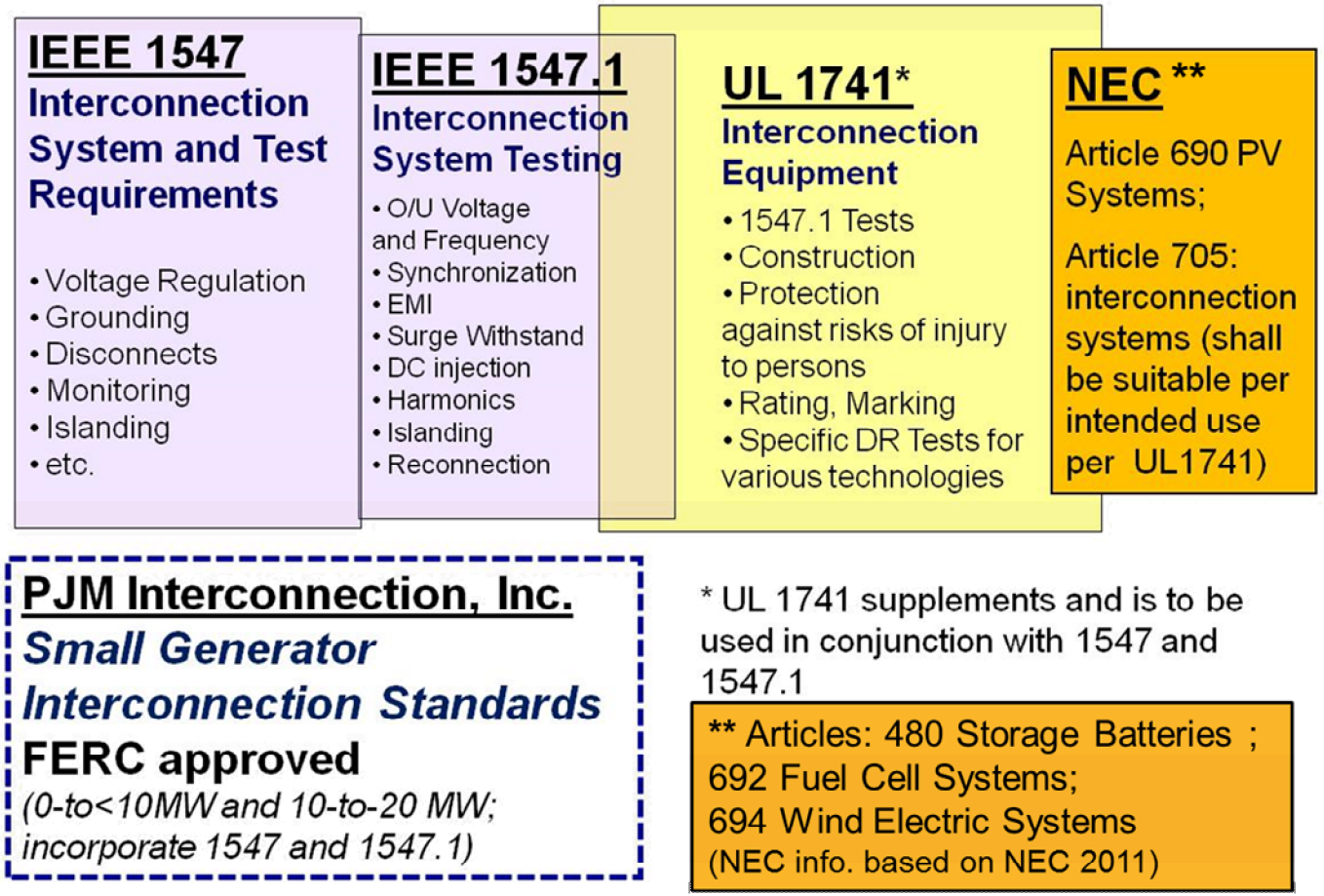
IFC & NFPA 1

- ✓ New table outlining the kW-Hours for different technologies subject to the code
- ✓ Maximum allowable quantities (MAQ)
- ✓ Maximum array (string) sizing
- ✓ Required physical separation distances
- ✓ Location parameters within buildings (and outside)
- ✓ Hazard mitigation analysis criteria
- ✓ Energy management systems
- ✓ Automatic charger disconnect
- ✓ Signage criteria
- ✓ Ventilation & gas detection
- ✓ Operational Permit added to IFC

NFPA-855

- New Technical Committee developing a comprehensive energy storage system standard
- First Meeting Was January 2017
- First Draft Posting April 11, 2018
- Covers all stationary storage applications
  - ✓ Fire protection
  - ✓ Placement and Siting
  - ✓ Thermal Management & Ventilation
  - ✓ Interconnection
  - ✓ General Battery Requirements

IEEE 1547 Standards Example Use in USA



SCC 21, a Level 2 Coordinating Committee within the IEEE Standards Association is also at work writing standards that deal with Interconnection of REN & ESS to the Grid (1547 series) , along with a group of Smart Grid standards (2030 series)

IEEE 1547 Latest Revision In PAR Process

Performance categories

Gives flexibility to accommodate different DER futures

More coordinated operation under normal conditions

Section 5 – many details on reactive power capabilities and voltage/power control requirements (not just allowance)

Grid support under abnormal conditions

Maintains distribution grid safety (cease to energize, trip on voltage or frequency when necessary)

Maintains bulk power system reliability (rides through voltage and frequency disturbances)

New guidance for interoperability

Starts us on the path to more open communications

Seeks to strike a balance between varying topologies & needs

New guidance for intentional islands

Much needed and immediate relevance

Testing requirements completely revised to address new capabilities

Strikes a balance between needs for large and small installs

Summary

- Newer battery technologies and large quantities of traditional batteries are an area of concern for public safety officials, fire departments, and building inspectors.
- These concerns have led to increasing regulations and criteria as proposed and developed in the 2018 IFC and 2018 NFPA 1. More changes for 2020 NFPA-855 and 2021 IFC.
- Battery manufacturers should be aware of the increased interest in requests for test data, fault data, and fire simulation work to satisfy code officials and meet the new code additions.
- End users should have a thorough understanding of these codes to determine types of technologies that can be readily deployed in existing structures, and installation and design issues for newer installations and facilities.
- Battery users, manufacturers, and researchers participation in the various code development bodies is encouraged.

IEEE ESSB and SCC 18 Opportunities

IEEE

- There are currently several open positions on NFPA TCs or CMPs that need to be filled -
  - If you are interested or want to learn more, contact Chris Hunter or visit the SCC 18 web page:

    http://sites.ieee.org/scc18/home/about/.

- Does belonging to SCC 18 mean I can be on an NFPA TC?
  - An IEEE SA and NFPA application process is required
  - The NFPA requires IEEE representatives to be users, or be able to represent users (consultants)
  - Employees of producers (manufacturers) are not eligible

- **IEEE ESSB** is open to all who have the following interests:
  - Have an interest in developing a technical understanding of the technologies related to energy storage, stationary batteries and related dc power systems.
  - Wish to help in the writing of standards (Best Practices and Guides) that ensure the safety, performance and reliability for the industry.
  - Willing to share SME knowledge thru technical symposiums, tutorials, etc.

- **IEEE ESSB** membership is made up of ….
  - Electrical, Chemical, Mechanical and other Engineers
  - Project, Test and Maintenance Engineers, Technicians
  - Installation and Testing Experts
  - Academia and R&D Scientists
  - Government Regulatory Engineers

Questions?

Next Actions

- Codes and standards reports to continue on a monthly basis
- Send questions to david.conover@pnnl.gov and we will have them answered
- The PPT used today with Q/A appended will be sent out and serve as the March 2018 C/S Report
- The next webinar date will be in September 2018
- Details on next webinar to be sent and will follow the same format as this webinar with advance materials forwarded via e-mail
- If there is something we should be covering in the monthly codes and standards report that we are not covering please let us know

THANK YOU

For more information on ESS safety related efforts….

david.conover@pnnl.gov

pam.cole@pnnl.gov

http://www.sandia.gov/energystoragesafety/

Acknowledgment

Dr. Imre Gyuk

DOE-Office of Electricity Delivery and Energy Reliability

PNNL-SA-#####/SAND2018-#####