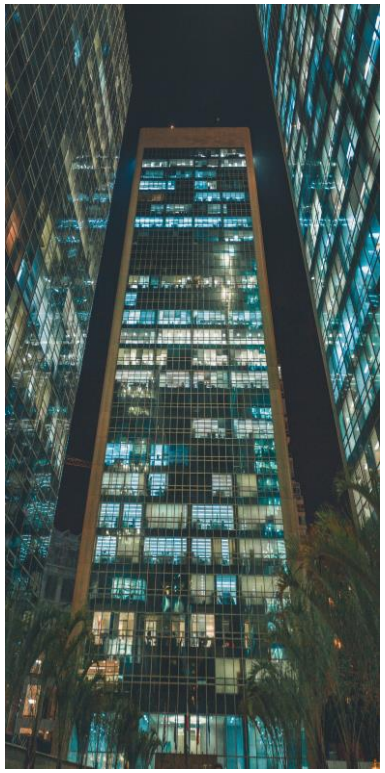
ESS Safety Codes and Standards – Which Way is Straight?

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

General Categories of Current Safety Codes and Standards



- **Fire Protection and Safety**
  - Includes fire suppression
  - Includes explosion control
- **Occupational risks and hazards**
  - Includes worker safety
  - Includes workplace safety
- **Design & Materials Safety**
  - Components are safe and products are reliable
  - Inspection, Testing & Maintenance (ITM) Requirements & Audits
- **Environmental safety**
  - Infrastructure and Buildings
  - Transportation over highways and by air

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

The Rise in Interest for Safety Codes and Standards

- Safety Codes and Standards have become important to the Energy Storage and Stationary Battery Communities
- Let's define the difference between a Safety Code and a Standard –
  - Code: A code is a model, a set of rules that knowledgeable people recommend for others to follow. It is not a law although it can be adopted into law. [the *'what'*]
  - Standard: A standard tends to be a more detailed elaboration, i.e. the nuts and bolts of meeting a code. [the *'how'*]
  - Neither becomes law until adopted by a regulatory authority.

NFPA - Reporter's Guide: About codes and standards.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

History of Fire Safety Codes & Standards

- Rome –64 AD
  - Widening of Streets
  - Home height restrictions
  - Fire resistant building materials

Fire in Rome
Hubert Robert (1785),
Open-Source

- London fire - 1666

The Great Fire in
London (1666),
Open Source

- **Chicago Fires**
  - 1871
  - 1903

- Others
  - **San Francisco**
  - **Baltimore**
  - **Boston**

Major City Burning
Open-Source

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

Birth of the NFPA & the ICC

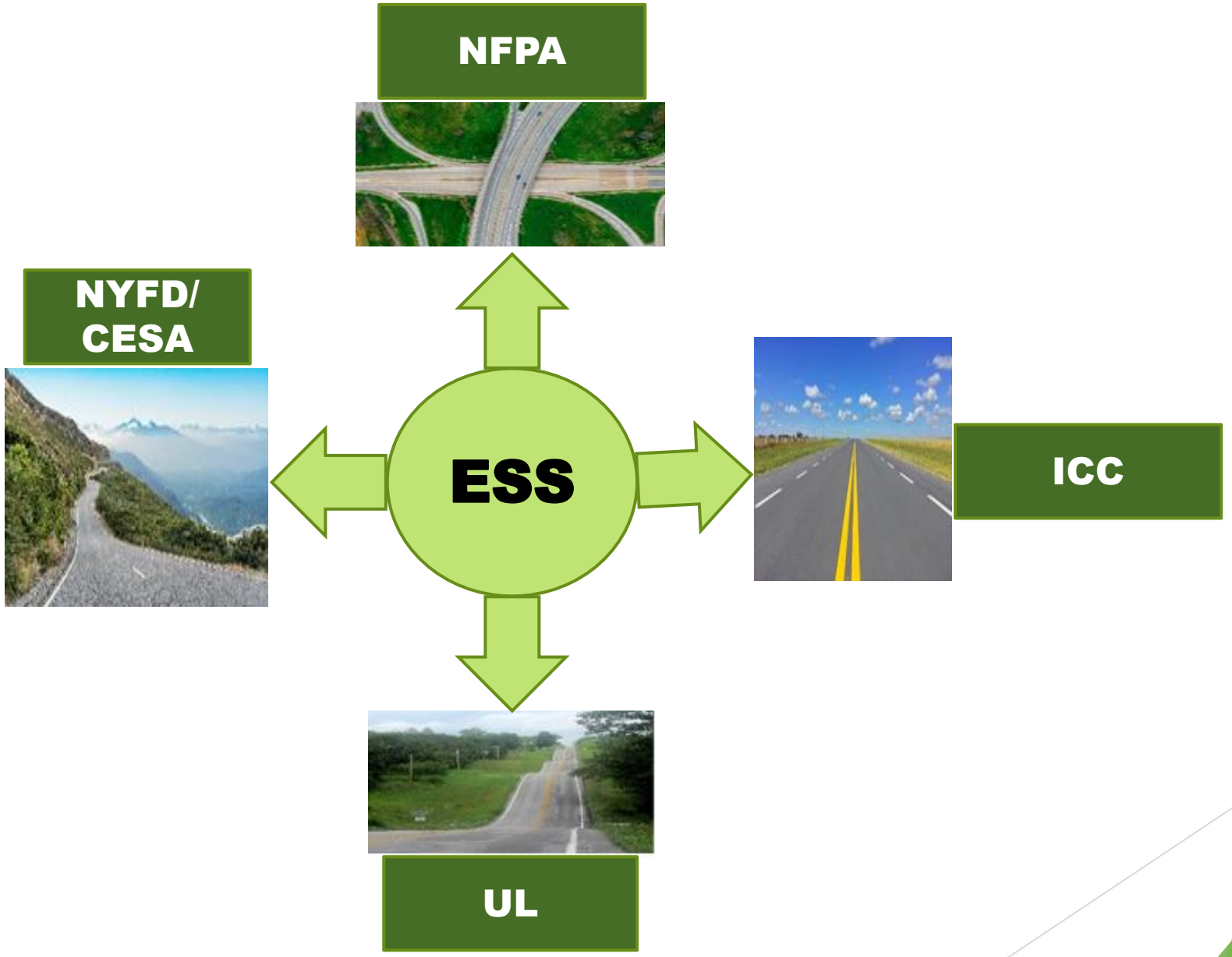
- Early beginnings of the NFPA
  - Formed in 1896
  - Birthright standards
    - What became NFPA 13 [First Standard]
    - Initial tenets for NFPA 70 (NEC)
      - National Conference on Standard Electrical Rules
      - Transferred to NFPA March 24,1911

Early Fire Suppression Sprinkler and Head, *History of Fire and Fire Codes, December 2021*

- Welcome the ICC
  - Formed in 1994 w/ 3 Regionals
  - Three Major I-Codes in 2000
    - International Fire Code
    - International Building Code
    - International Residential Code

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

WHICH WAY IS STRAIGHT?



OSHA
IEEE
IEC
CSA
NERC
FERC
NEMA
ISO
ANSI
FCC
FM GLOBAL
MESA
ETC.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

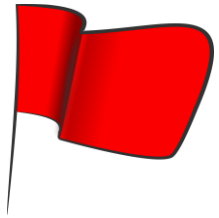
How Codes Get Implemented

Code
- **NFPA 1**
- **IFC**

References a Standard
- **NFPA 855**

AHJ or Regulatory Agency Adopts

A Code is enforceable when adopted by the AHJ or Regulatory Agency



The First Challenge facing NFPA 855

Note: There are 21 NFPA Standards referenced in 855:2.2 and 10 UL standards in 855:2.7 plus 9 other referenced standards.

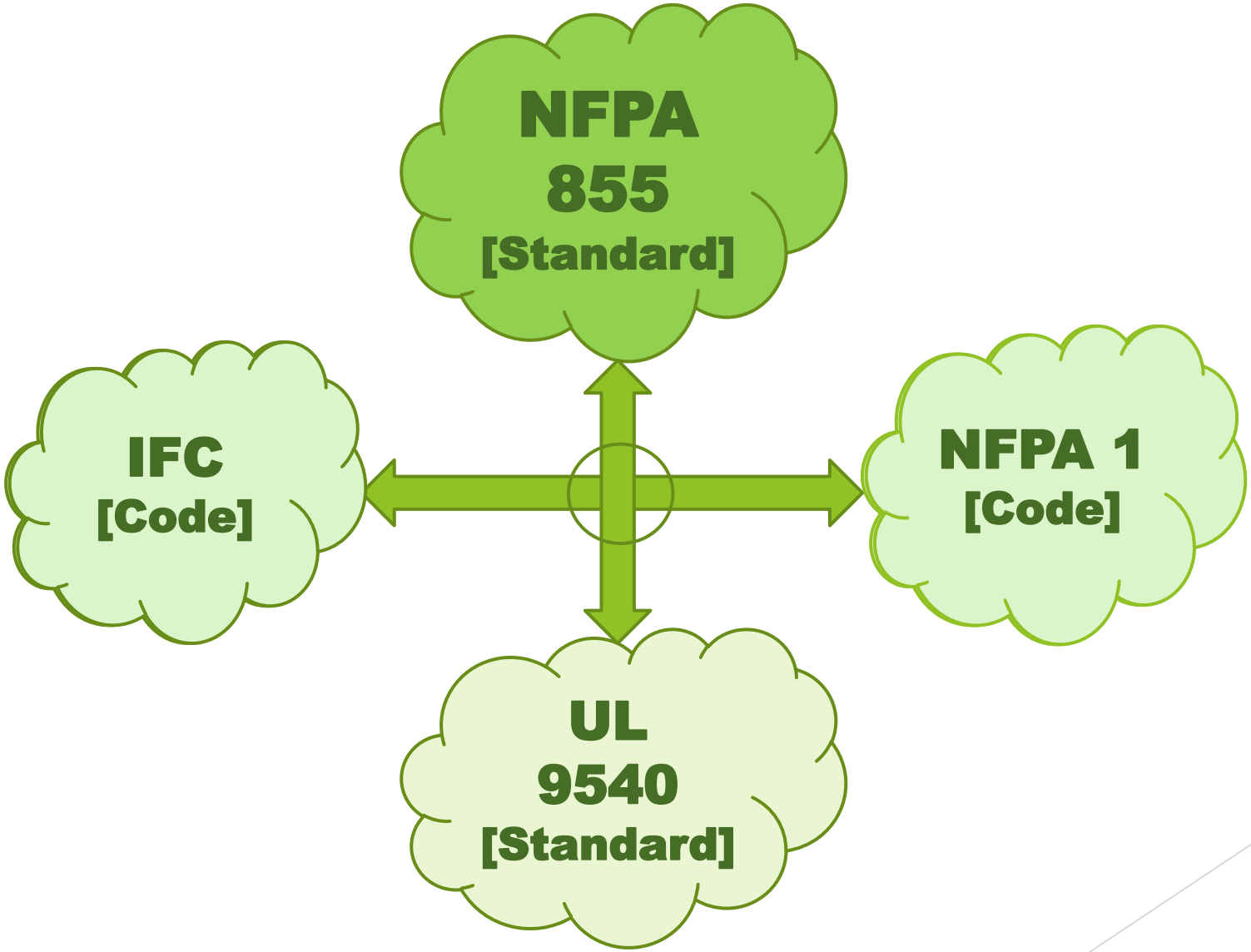
Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

IFC = 42 States
+ Puerto Rico
& Virgin Islands

NFPA = 8 States

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

a Look from an ESS Perspective



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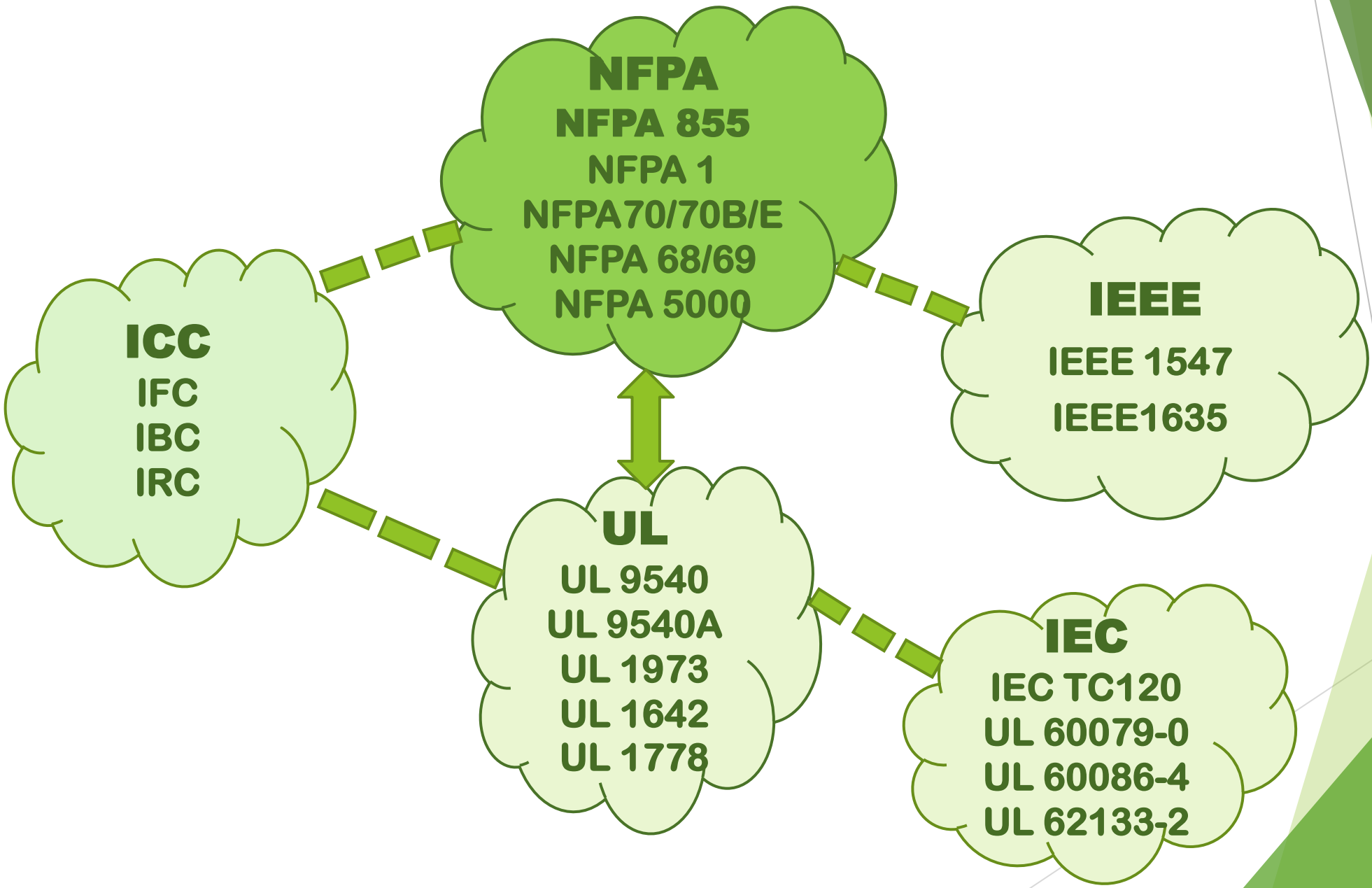
Independent Consultant
CGS and Associates
McKinney, TX

a Deeper Look from an ESS Perspective



Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

NFPA 855 – the Bellwether ESS Standard

NFPA 855

- Began as project between DOE and NFPA Fire Protection Research Foundation on request by the California Energy Storage Alliance in April 2016.
- First release in December 2019 (NFPA 855-2020) was controversial and published without a scope. First revision (NFPA855-2023) can be viewed and/or purchased via the NFPA website (www.nfpa.org).
- New release builds upon lessons learned from the McKinnon incident in Sunrise AZ and other events.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

NFPA 855 – the Bellwether ESS Standard

NFPA 855

- Key Elements of NFPA 855-2023
  - Addresses stationary storage applications including ESS with standby application carveouts/exceptions for Pb-acid, Ni-Cd.
  - Now covers all commercially available BESS technologies including Li, Pb-Acid, Ni-Cd, Sa, Ni, Flow and Zinc plus mechanical Flywheel.
  - Requires UL listings for all devices used in ESS applications including Li, Pb-acid, Ni-Cd, alternative BESS + inverters, UPS, related equipment (UL 9540)

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

NFPA 855 – the Bellwether ESS Standard

NFPA 855

- Key Elements of NFPA 855-2023 (2)
  - Thermal runaway and explosion testing (UL 9540A).
  - Explosion protection by deflagration venting (NFPA 68) and explosion control/prevention (NFPA 69).

  - Interconnection and commissioning/ decommissioning.

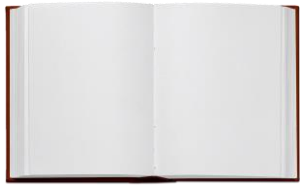
Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

NFPA 855 – the Bellwether ESS Standard

- Key Elements of NFPA 855-2023 (continued)

NFPA 855

- All electrochemical technology requirements now placed in Chapter 9.
- Separate chapter addresses Lithium Metal and Li-ion battery storage in Chapter 14.
- Residential requirements are consolidated in Chapter 15.
- Solid annex material in Annex B & Annex G.



Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

NFPA 855 2023 – In Summary

NFPA 855

Chapter / Annex	Description	# Pgs
TofC	Table of Contents	6
1	Administration	2
2	Referenced Publications	3
3	Definitions	4
4	General	10
5	System Interconnections	1
6	Commisioning	3
7	Operation and Maintenance	2
8	Decommissioning	8
9	Electrochemical ESS	24
10	(Reserved)	-
11	Fuel Cell ESS	1
13	Flywheel ESS	3
14	Storage of Li Metal or Li-Ion Batteries	3
15	One and Two--Family Dwellings & Townhouse Units	2
Annex A	Explanatory Material	15
Annex B	BES System Hazards	14
Annex C	Firefighting Considers (Operations)	5
Annex D	Overview of ESS Technologies	5
Annex E	Permits, Inspections, Approvals and Connections	2
Annex F	Fire and Building Codes: Short History on Stationary Storage Battery Systems	7
Annex G	Guide for Suppression and Safety of Li-Ion Battery (LIB) ESS	53
Annex H	Informational References	5
	TOTAL NO. OF PAGES:	>150

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

A Few Key Takeaways – NFPA 855 2023

- *Threshold Quantities* for each fire area or outdoor installation (from Table 1.3 of NFPA 855)*

ESS Technology	kWh	MJ
Lead-Acid, all types	70	252
Ni-Cad, Ni-MH and Ni-Zn	70	252
Li-ion, all types	20	72
Sodium nickel chloride	20 (70[1])	72 (252[1])
Flow Batteries	20	72
Other battery technologies	10	36
Batteries in 1 and 2 family dwellings**	1	3.6
Electrochemical double-layer capacitors	3	10.8
All other ESS	70	252

Table is not an exact copy of Table 1.3 but is factually correct.
****This requisite is taken from Chapter 15, Section 15.1.***
[1] If UL 1973 listed and meets requirements of UL 9540A, TQ's raised to this level.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

A Few Key Takeaways – NFPA 855 2023

- Table 9.4.1 defines *Allowable Maximum Stored Energy*[1]

ESS Technology	kWh[a]
Lead-Acid, all types	Unlimited
Nickel Batteries[b]	Unlimited
Li-ion, all types	600
Sodium nickel chloride	600
Flow Batteries[c]	600
Other battery technologies	200
Batteries in 1 and 2 family dwellings*	80
Electrochemical double-layer capacitors	20
All other ESS	200

[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, and other flowing electrolyte-type technologies

** This requisite is taken from Chapter 15, Section 15.5.2.*

[1] Information is not exact table, but data is accurate.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

A Few Key Takeaways – NFPA 855 2023

- **Work has already begun on the 2026 version**
  - Public input for 2026 edition just closed 05/31/2023.
  - First draft report will be released no later than 03/21/2024.
  - Second public comment period will then open until 05/30/2024. *Note: comments can only address previous Draft 1 comments.*
  - Second Draft Report Posting Date 02/27/2025
  - NITMAM closing date is 03/27/2025.
  - **Next release – late 4Q 2025.**

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

SUMMARY AND CONCLUSIONS

1. Energy Storage is Here to Stay.

2. Safety Codes and Standards continue to be a critical piece of the ESS equation.

3. Currently electrochemical technologies are the main commercial device for storing energy to be used at a later date, at least for the immediate future.

4. New technologies in varying stages of final dress rehearsal (flow, zinc, sodium, CAES, hydrogen) are jockeying to play in the mid and LDES markets.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

SUMMARY AND **CONCLUSIONS**

1. An education and training initiative is required to bring AHJ's and regulatory bodies up to speed on NFPA and ICC with an incentive to update outdated editions to the current level.

2. Key players in the ESS space need to continue an involved role in the various SDO's.

3. A means to correlate the varying editions/versions of the interrelated standards to the same editions and reflection of requirements.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX

Thank You!

And thanks to the team at Sandia who put this Forum together and to the Office of Electricity for continuing to recognize rethe importance of safety and reliability for energy storage systems.

Chris Searles,
Independent Consultant
CGS and Associates
McKinney, TX