# Installing ESS Behind the Meter: An Update on the Regulatory Environment

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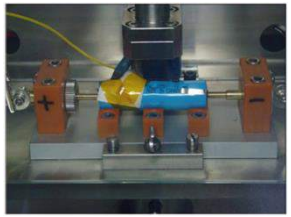
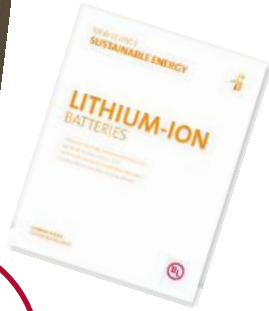
# Leader in Advanced Battery Safety Science










**UL 810A: Electrochemical Capacitors**
**UL 1973: Stationary Applications**
**UL 2271: Light Electric Vehicles**
**UL 2272, Electrical Systems for Self-Balancing Scooters**
**UL 2743, Portable Power Packs**
**UL 2580: Electric Vehicles**
**UL 9540: Energy Storage Systems**
**UL 3100: Distributed Energy**

# Agenda

**Introduction to Codes Impacting ESS Installed Behind the Meter**
Introduction to Codes
**Revisions to Model Codes**
NFPA 70
ICC IFC
NFPA 1
ESS Compliance Guide
**UL ESS Standards Revisions/Updates**
UL 9540
UL 3001 and Other UL Standards
**Certification Overview**

# Introduction to the Codes Impacting ESS Installed Behind the Meter

# Introduction to Codes

The US DOE held an Energy Storage Safety Workshop in February 2014

- Gaps noted in codes & Standards
- DOE ESSWG Codes & Standards Task Group established 2015
  - Identified gaps in the current model codes with regard to electrical energy storage systems (ESSs) were identified
  - Need for an ESS Installation standard similar to NFPA 853 for fuel cells
  - Interim Guide for installation

# Introduction to Codes


Municipalities, Regional and State Governments rely upon the model codes to regulate the installation of electrical equipment

# Introduction to Codes

Organizations such as NFPA and ICC develop model codes that can be used by local municipalities for use in their particular building, electrical, etc. codes.

- The following are examples of model codes:

NFPA 70, National Electrical Code (NEC)

ICC International Fire Code (IFC)

NFPA 1, Fire Code

# Revisions to Model Codes

# NFPA 70

## NFPA 70, National Electrical Code (NEC)

- Code utilized for municipal, regional and state electrical regulations

## During DOE 2014 Safety Workshop

- NEC identified as code to be updated to address EESS

## A task group established in 2014

- Developed proposal for new Art 706 addressing EESS
- Art 706 accepted for inclusion in 2017 NEC

## Code development process near completion

# NFPA 70

## Article 706, Energy Storage Systems

### Scope: Permanently installed ESS, stand-alone or interactive

- Energy Storage System, Self-contained
- Energy Storage System, Pre-engineered of Matched Components
- Energy Storage System, Other

### Listing:

- Equipment that makes up the ESS shall be listed for the application as part of ESS
- Prepackaged self-contained systems shall be permitted to be listed

### Construction

- Disconnecting means
- Spaces About ESS Components - comply with 110.26
- Pre-engineered, self-contained – per mfg. recommendations
- Egress, doors open out and supplied with panic hardware
- Lighting – provided for workspaces
- Directory
- Disconnection of series connected battery into ≤ 100 V for maintenance

# ICC IFC

Revisions to Chp. 608 - Stationary Storage Battery Systems for 2018 IFC

**Segregation** – Arrays segregated in 50 kWh systems with some exceptions

- Lead acid and Ni-Cad
- Listed, pre-engineered li-ion arrays not to exceed 250 kWh
- Listed, pre-engineered stationary battery systems not to exceed 150 kWh
- Listed, pre-engineered systems can be larger if full scale fire/fault testing conducted and approved by AHJ

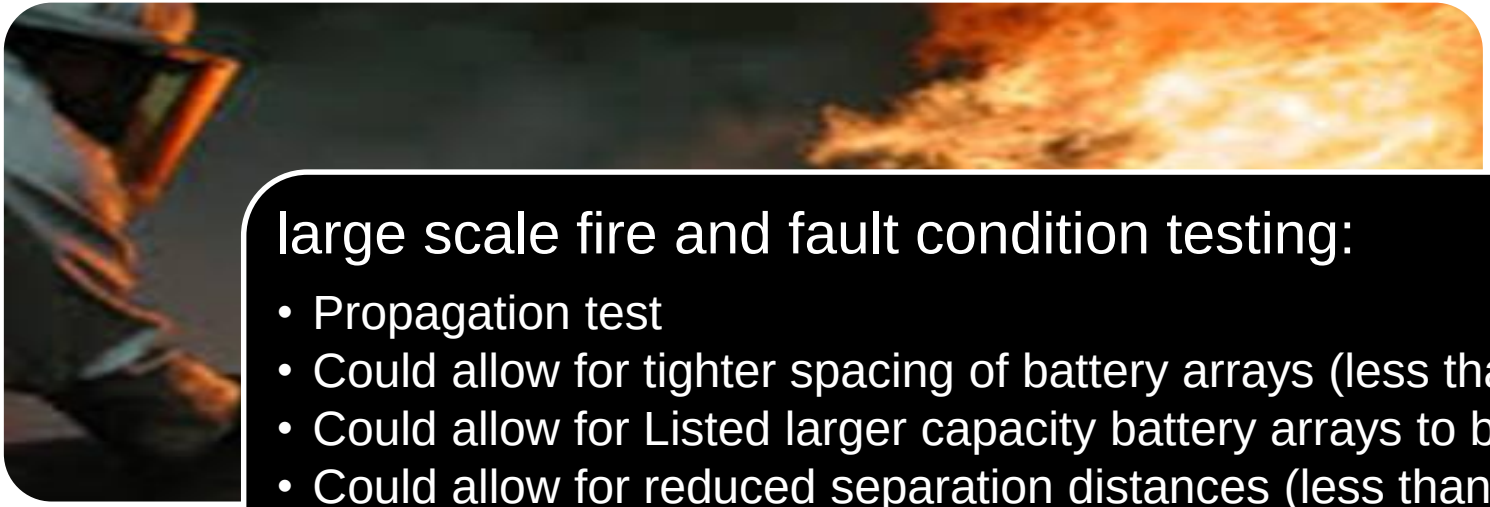
An approved energy management system shall be provided except for LA and Ni-CAD

## Maximum Allowable Quantities

| Battery Technology | MAQs | Group H Occupancy |
|---|---|---|
| Lead Acid | Unlimited | NA |
| Ni-Cd | Unlimited | NA |
| Lithium (all) | 600 kWh | H-2 |
| Sodium (all) | 600 kWh | H-2 |
| Flow | 600 kWh | H-2 |
| Other | 200 kWh | H-2[c] |

[c] Shall be a Group H-4 occupancy if the fire code official determines there is a lower hazard level

# ICC IFC



large scale fire and fault condition testing:

- Propagation test
- Could allow for tighter spacing of battery arrays (less than 3 ft)
- Could allow for Listed larger capacity battery arrays to be used
- Could allow for reduced separation distances (less than 5 ft)
- Could allow for reduced separation from means of egress (less than 10 ft)
- Proposed test method for lithium ion batteries to be developed for informative annex of UL 1973.

# NFPA 1

Proposals for NFPA 1, 2018 Edition

52.2 Listings and approvals:

- 1) Lead-acid and nickel-cadmium batteries shall be approved or listed and labeled in accordance with UL1973 or UL 9540
- 2) Battery technologies not covered by item 1 shall be listed and labeled in accordance with UL1973 or UL 9540

52.4 A fire risk and failure modes/effects analysis that includes information on hazard mitigation related to the following items shall be provided to the AHJ and approved:

- Safety caps
- Thermal runaway management
- Spill control
- Neutralization
- Ventilation
- Signage
- Seismic protection
- Fire detection
- Fire suppression
- Fire-resistance separation rating; both vertical and horizontal

# NFPA 1

- Systems that need to show compliance with Chp. 52:
  - Lead acid and Ni-Cad: With electrolyte capacity of more than 100 gal (378.5 L) in sprinklered buildings or 50 gal (189.3 L)
  - Li-ion and Lithium metal polymer: With a power rating greater than 7 kWh (25.2 Mega joules)
  - Other technologies: That exceed  ten lbs (4.6 kgs)

| Requirements | Flooded LA | Ni-Cad | VRLA | Li-ion | Li metal polymer |
|---|---|---|---|---|---|
| 1. Safety caps<br>2. Thermal runaway mgmt.<br>3. Spill control<br>4. Neutralization<br>5. Ventilation<br>6. Signage<br>7. Seismic Control<br>8. Fire detection | 1. Vent caps<br>2. NA<br>3. Required<br>4. Required<br>5. Required<br>6. Required<br>7. Required<br>8. Required | Same as Flooded LA | 1. Self- resealing flame arresting caps<br>2. Required<br>3. NA<br>4. NA<br>5. Required<br>6. Required<br>7. Required | 1. NA<br>2. Required<br>3. NA<br>4. NA<br>5. NA<br>6. Required<br>7. Required<br>8. Required | Same as Li-ion |

# ESS Compliance Guide

## Long Term Goal for ESS Installation Standard through NFPA:

- NFPA ESS-AAA technical committee for energy storage set up
- Proposed new standard NFPA 855, “Installation of Stationary Energy Storage Systems” to be part of this work
- Addresses the design, construction, installation, and commissioning of stationary energy storage systems
- Use NFPA 853 for fuel cell system installation as a beginning template to developing NFPA 855

## Interim Measure from ESSWG for Codes & Standards:

## PNNL-SA-118870 / SAND2016-5977R, Energy Storage System Guide for Compliance with Safety Codes and Standards

- Published June 2016 and available on DOE website
- “covers the design and construction of stationary energy storage systems (ESS), their component parts and the siting, installation, commissioning, operations, maintenance, and repair/renovation of ESS within the built environment with evaluations of those ESSs against voluntary sector standards and model codes that have been published and adopted as of the publication date of this CG.”

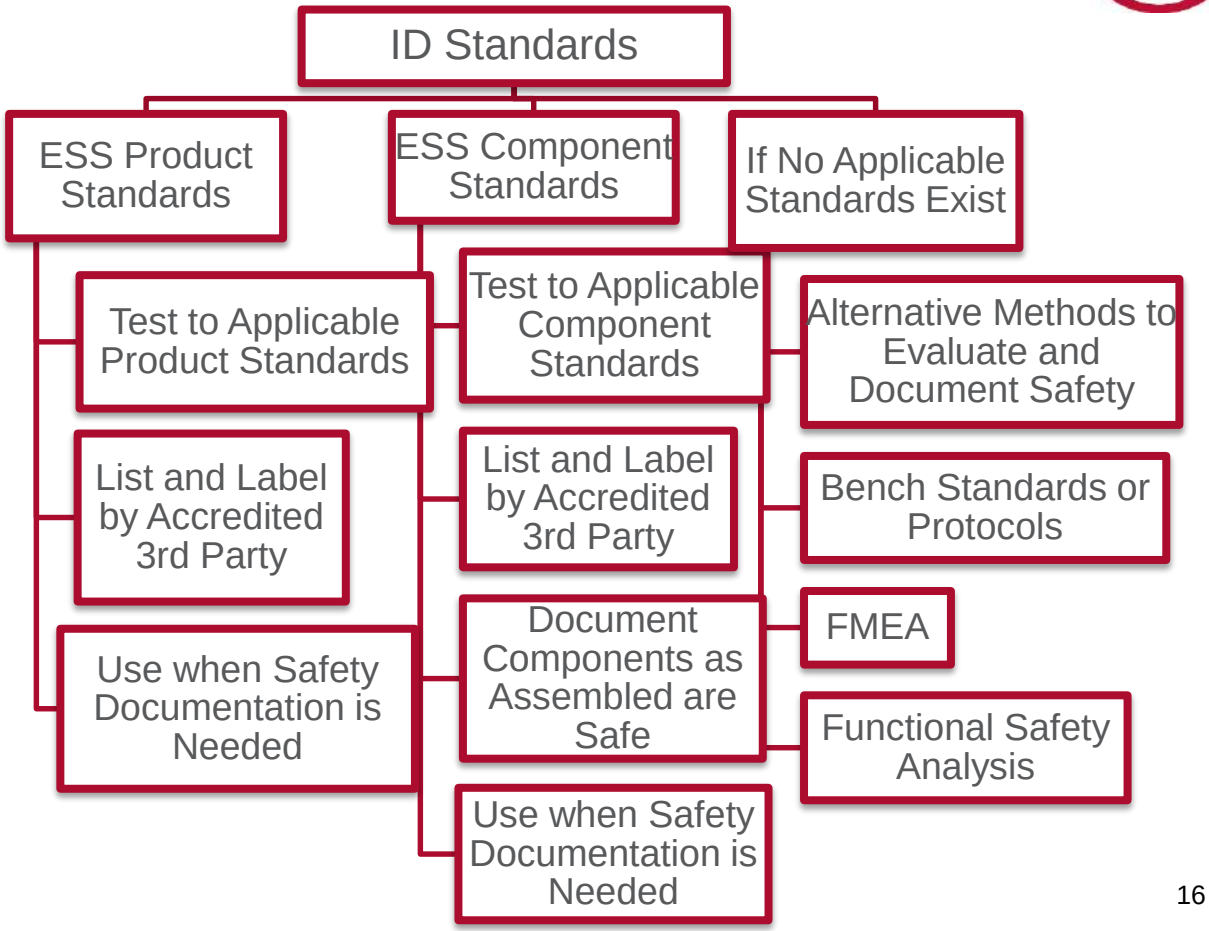
Sandia National Laboratories

Pacific Northwest NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

# ESS Compliance Guide

Chart from ESS Compliance Guide



# UL ESS Standards Revisions/Updates

# UL 9540

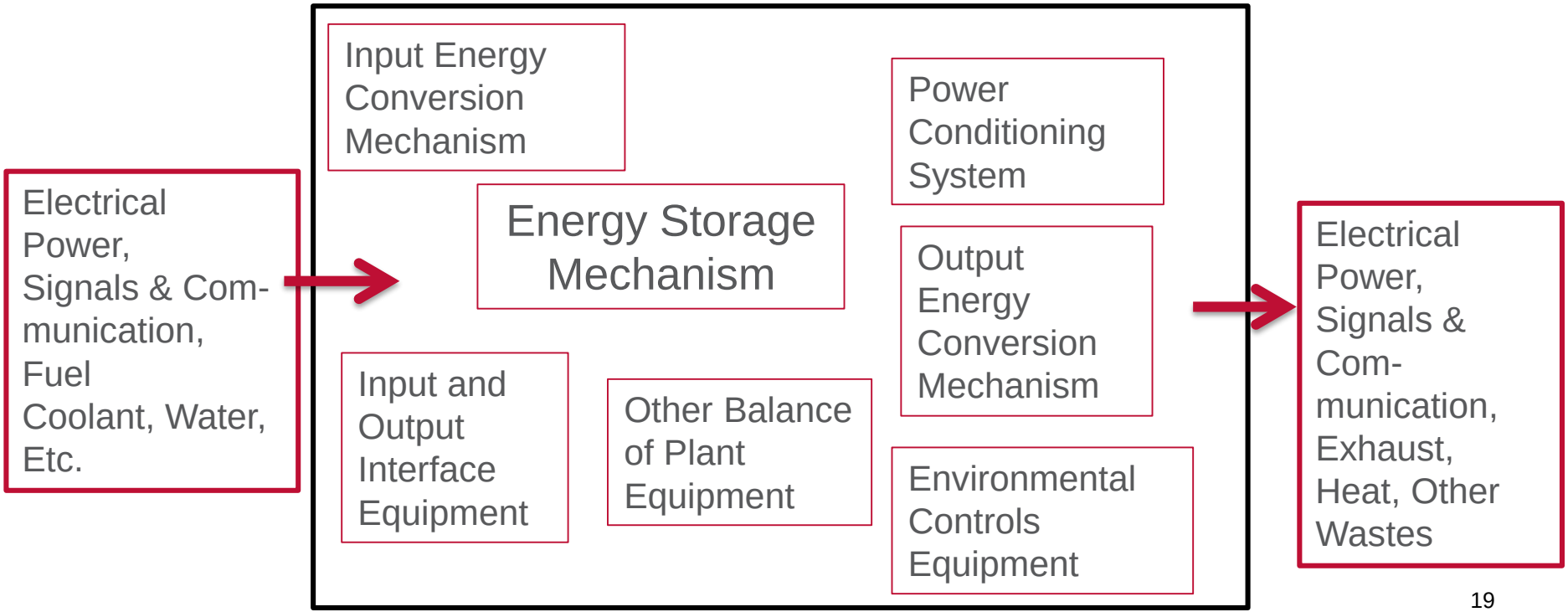
## UL 9540, Energy Storage Systems and Equipment

### Scope:

- energy storage systems that are intended to store energy from power or other sources and provide electrical or other types of energy to loads or to the local/area electric power system (EPS) up to the utility grid
- The systems covered by this standard include those intended to be used in a standalone mode (e.g. islanded) including “self-supply” systems to provide electric energy and those used in parallel with an electric power system, or electric utility grid such as “grid-supply” systems, or applications that perform multiple operational modes.

# UL 9540

## Block Diagram of an Electrical Energy Storage System



# UL 9540

## Examples of Energy Storage Systems

| Technology | Input Energy Conversion Mechanism | Energy Storage Mechanism | Output Energy Conversion Mechanism |
|---|---|---|---|
| Electrochemical | Charger | Battery System | Converter |
| Chemical | Water Electrolysis Hydrogen Generator | Hydrogen Storage | Combustion Generator or Fuel Cell |
| Mechanical | Air Compressor | Flywheel | Motor Generator |
| Thermal | Heat Pump | Thermal Storage | Heat Generator or Heat Exchanger |

# UL 9540

## Construction

- Components
- FMEA
- Materials
- Enclosures
- Wiring
- Insulation, Electrical Spacings, and Grounding
- Inverter/Converter
- Technologies
- Fluid Containment
- Controls, Protection Devices
- Lighting, HVAC, etc.
- Markings and Signage
- Instructions

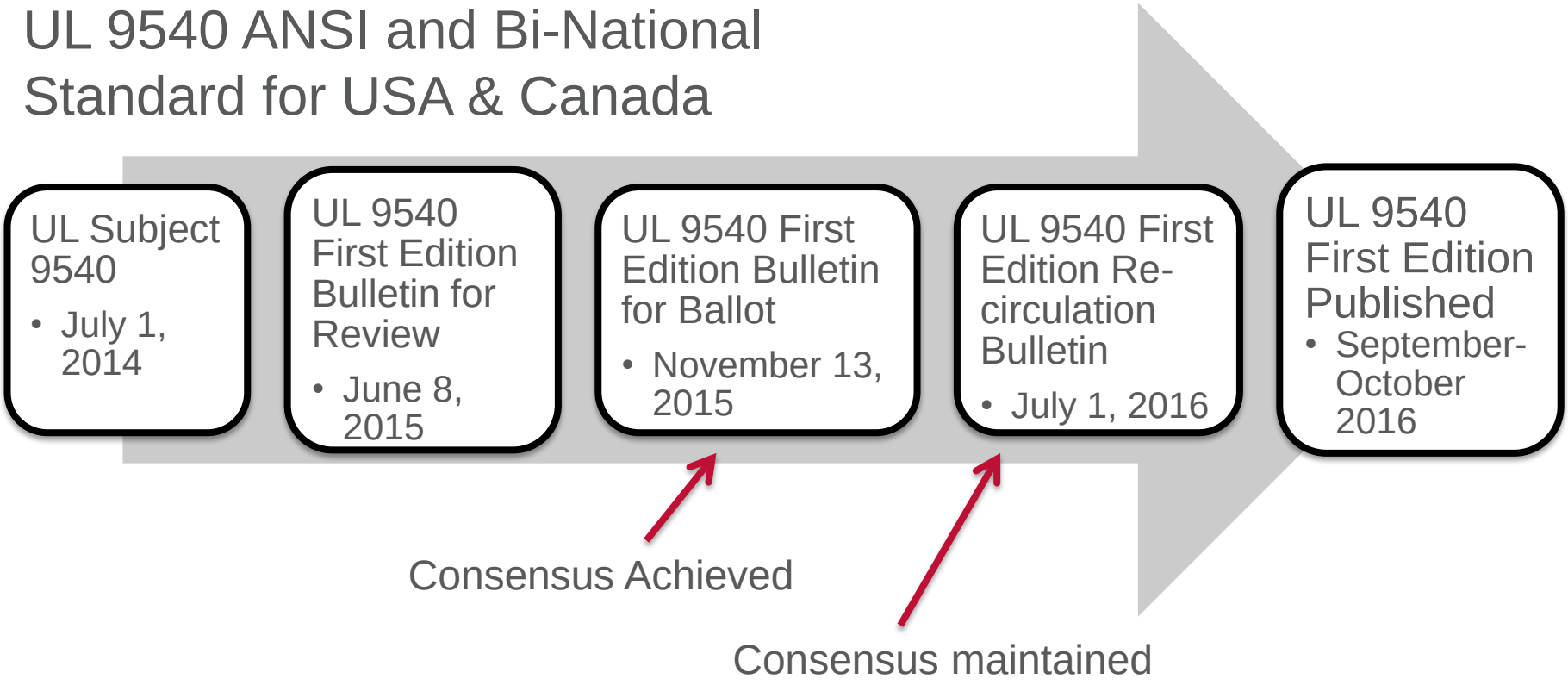
## Tests

## Type

- Normal Operations
- Dielectric Voltage Withstand
- Impulse
- Grounding and Bonding
- Insulation Resistance
- Overspeed Qualification
- Faulted Securement Qualification
- Blocked Shaft Qualification
- Mechanical Failure Qualification
- Leakage
- Strength
- Moisture exposure
- Salt Fog
- Seismic Rating

# UL 9540

## UL 9540 ANSI and Bi-National Standard for USA & Canada



# UL 3001 and Other UL Standards

**UL 3001**, Distributed Energy Generation and Storage Systems

- Establishing STP and Developing 1st Bulletin

**UL 1973**, Batteries for Use in Light Electric Rail and Stationary Applications (1st edition, ANSI standard published)

- Major revisions published in June 2016
- Next step is to become bi-national standard for USA and Canada

**UL 1741**, Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (2nd edition published)

- Revision to add Supplement SA - Grid Support Utility Interactive Inverters And Converters
  - validate compliance with grid interactive functions which are not yet covered in IEEE 1547-2003
  - Consensus Achieved and Resolving Comments

# ESS Certification

# Certification

## Certification of ESS

- Self-contained, Factory Matched ESS
- 3rd party certification
- Ongoing Production Inspection

## Certification of Components that Make up an ESS

- Field Assembled ESS
- 3rd party certification of Major Components
- Ongoing Production inspection of the Major Components

## Field Labeled


- 3rd Party Field Evaluation of System at Specific Site
- May require certification of major components
  - Functional Safety Investigation

# THANK YOU.