NFPA 855
UL9540
UL9540A
Popular View of the Evolution of the Electric Grid
Whatever!
New Chapter being approved for inclusion in the 2018 International Fire Code, Chapter 12 Energy Systems

A major change within this work was the introduction of array (unit) spacing:

1206.2.8.3 Stationary battery arrays. Storage batteries, prepackaged stationary storage battery systems and pre-engineered stationary storage battery systems shall be segregated into stationary battery arrays not exceeding 50 kWh (180 megajoules) each. Each stationary battery array shall be spaced not less than 3 feet (914 mm) from other stationary battery arrays and from walls in the storage room or area.

1206.2.10.4 Battery chargers. Battery chargers shall be compatible with the battery chemistry and the manufacturer’s electrical ratings and charging specifications. Battery chargers shall be listed and labeled in accordance with UL 1564.

1206.2.10.5 Inverters. Inverters shall be listed and labeled in accordance with UL 1741. Only inverters listed and labeled for utility interactive system use and identified as interactive shall be allowed to operate in parallel with the electric utility power system to supply power to common loads.
Applicable UL Standards

Standard Description
UL 9540 Standard for Energy Storage Systems and Equipment
UL 1642 Standard for Lithium Batteries (Cells)
UL 1973 Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications
UL 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
UL 1564 Industrial Battery Chagers
UL 1008 Standard for Transfer Switch Equipment
UL 3001 Outline for Investigation for Distributed Energy Generation and Storage Systems
UL 1778 Uninterruptible Power Supply Systems

UL 9540 compliant (Energy Storage System Listing) =
including UL 1741 standard for inverters + UL 1973 standard for stationary batteries

Increasing ESS compliance requirements
UL 9540
2017 NEC Sect. 706
NFPA 855
UL 9540A
Developing IEC standards
IEC 62932 - Flow
IEC 62933 - ESS
Repurposing of batteries – UL 1974
SCOPE OF NFPA 855

- This standard establishes criteria for minimizing the hazards associated with energy storage systems (ESS).

<table>
<thead>
<tr>
<th>ESS Technology</th>
<th>Aggregate Cap. (kWh)</th>
<th>Aggregate Cap. (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead-acid (all)</td>
<td>70</td>
<td>252</td>
</tr>
<tr>
<td>Nickel (including NiCad, NiMH, NiZn)</td>
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<td>252</td>
</tr>
<tr>
<td>Lithium Ion (all)</td>
<td>20</td>
<td>72</td>
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<tr>
<td>Sodium Nickel Chloride</td>
<td>20</td>
<td>72</td>
</tr>
<tr>
<td>Flow Batteries</td>
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<td>72</td>
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<tr>
<td>Other Battery Technology</td>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>Batteries in 1 or 2 family dwelling</td>
<td>1</td>
<td>3.6</td>
</tr>
<tr>
<td>Electrochemical Double Layer Capacitor</td>
<td>3</td>
<td>10.8</td>
</tr>
<tr>
<td>All other ESS</td>
<td>70</td>
<td>252</td>
</tr>
</tbody>
</table>
UL 9540 addresses key issues associated with energy storage systems, including:
- Battery system safety
- Functional safety
- Grid connectivity
- Interconnection with premises wiring systems
- Environmental performance
- Containment
- Fire detection and suppression

Safety standard for Energy Storage Systems intended for connection to a local or utility grid or for a standalone application
- Intended for electrochemical, chemical, mechanical and thermal types

UL 1973 + UL 1741 = UL 9540

UL 9540A Overview


UL 9540A is NOT a Standard but is currently referenced in NFPA 855 draft

Goal is to provide quantitative data to characterize potential ESS fire events
Testing is done at the cell, module, unit, and possibly the installation level

Execution of this test method will be a significant undertaking
This will be referenced in UL 9540 in the future
UL 9540A Test Method
IFC 2018 and NFPA 855

Large scale fire test concept
• Evaluates the fire characteristics of a battery ESS that undergoes thermal runaway.
• The data generated will be used to justify MRE (MAQ) and size increases, spacing decreases, sprinkler densities, need for exhaust
• Cell level test
• Module level test
• Unit level test
• Installation level test
• Appendix - Test concepts and application of test results to installations
Other arrangements as approved by AHJ based on large scale fire and fault condition testing.

Max. 50 KWh each

Max. 250 KWh each for listed systems

Spaced min. 3 ft. from other arrays and from walls.
UL 9540A Test Method

Cell level testing
- Determine the best method for inducing thermal runaway
- Measure temperature at venting and thermal runaway, and parameters of cell vent gas

Module level testing
- Determine if thermal runaway will propagate with the module
- Determine heat release and gas composition

Unit level testing
- Determine if thermal runaway will progress to the full ESS
- Characterize heat release, temperatures, gas composition, and re-ignition hazards

Installation level testing – if required
- Determine the effectiveness of the fire protection system
UL 9540A Test Hierarchy

**Cell Level Test**
- Whether cell can exhibit thermal runaway
- Thermal runaway characteristics
- Gas composition (flammability)

**Module Level Test**
- Propensity for propagation of thermal runaway
- Heat and gas release rates (severity/duration)
- Flaming/deflagration hazards

**Unit Level Test**
- Evaluation of fire spread
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards

**Installation Level Test**
- Effectiveness of fire protection system(s)
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards
UL 9540A Unit Level Testing

Critical Information:
1. Heat release rate  AHJ hazard mitigation analysis
2. Gas generation/composition  Data for NFPA 68/69
3. Explosions/flying debris  UL Performance requirement
4. Target unit and wall surface temperatures  UL Performance requirement
5. Target unit and wall surface heat flux  AHJ hazard mitigation analysis
UL 9540A Installation Level Testing (Effectiveness of Fire Suppression Methods)

Critical Information:
1. Fire suppression system performance evaluated
2. Explosions/flying debris  UL Performance requirement
3. Flaming out of test room  UL Performance requirement
4. Flame spread in cable tray  UL Performance requirement
5. Target unit and wall surface temperatures  UL Performance requirement
6. Target unit and wall surface heat flux  AHJ hazard mitigation analysis
Quick overview of a solar system & UL

- PV Modules
  - AC Modules – UL 1703, UL 1741 (QHYZ)
  - BIPV – UL 1703, UL 790, & UL 997 (QNYK)
  - Flat plate – UL 1703 (QHYL, QIGU, QIGZ, QIJA)
  - Concentrator – UL 8703 (QIEP)

- Rack Mounting Systems
  - UL 2703 (QHY5)

- BIPV Mounting Systems
  - UL 1703 (QHY0)

- PV Wire
  - UL 4703 (ZKLA) or USE-2 Cable UL 854 (TLY2)

- Cable
  - UL 3003 (QH5R) or DG Wiring Systems UL 9703 (QH25)

- Combiner Box
  - UL 1741 (QHYQ)

- DC Disconnect
  - UL 9BB (WH0X, WIBC, WHVA)

- Connectors
  - UL 6703 (QIQA, QIIX)

- Rapid Shutdown
  - UL 1741 (QIUS, QIUSI)

- Utility Meter Sockets
  - UL 414 (PWSZ, PAAI)

- Meters
  - UL 2735 (QOCZ)

- AC Disconnect
  - UL 98 (WAX, WH5S)

- PV Generation Meter
  - UL 516 or UL 61010-1 (FTIC)

- or UL 2735 (QOCZ)

- Distribution Panel
  - UL 67 (QLEU)
THANK YOU!