

UNDERWRITERS LABORATORIES INC. CERTIFICATION REQUIREMENT DECISION

This Certification Requirement Decision is prepared by UL LLC. It is normative for the applicable UL Product Certification Program(s); however, it is currently not part of the UL Standard(s) referenced below.

Product Category (CCN): BBCV2, BBGA2, BBFX, BBFX2, FTBW

Standard Number: UL 9540A

Standard Title: Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Edition Date: June 15, 2018

Edition Number: 3

Section / Paragraph Reference: 4.6A (new), 6.A (new), 6.1.1, 6.2.2, 6.2.2.1 (new), 6.2.4, 6.2.6

Subject: Cell Testing Procedure Details for UL 9540A

DECISION:

(NEW) 4.6A Maximum Surface Temperature End Point – The final hold temperature measured on the cell case after conducting the thermal ramp using the heater method to achieve thermal runaway of the cell.

6 Cell Level

(NEW) 6.A This portion of the test is to establish the most effective method for forcing a cell into thermal runaway in a repeatable manner that can be used at the module, unit and installation level of testing. During this portion of the testing, the vent gas composition is gathered and analyzed and temperatures are monitored to determine the temperature when the cell vents and to verify that thermal runaway as defined in this document, has occurred.

6.2 Determination of thermal runaway methodology

6.2.2 The propensity of the cell to exhibit thermal runaway shall be demonstrated by heating the cell with an externally applied flexible film heaters that cover as much of the cell case as possible without covering safety features or terminals, for consistent heating of the internal cell electrode assembly. A surface heating rate of 45°C (7.29°F) to 7°C (12.6°F) per minute shall be applied to the cell. Determination of a maximum surface temperature end point criteria shall be developed based upon a review of cell design and chemistry. If external heating with a flexible film heater does not cause a cell to exhibit thermal runaway, one of the following methods shall be employed:

- a) Mechanical;
- b) Overcharging, over discharging or short-circuiting; or
- c) Use of alternate heating sources.

(NEW) 6.2.2.1 For Li-ion technology cells, the maximum surface temperature end point shall be a minimum of 5°C greater than the melting temperature of the cell separator material as determined from differential scanning calorimetry (DSC) data of the separator. If thermal runaway is not achieved at this maximum temperature based upon the separator melting temperature, the cell heating rate according to 6.2.2 shall continue until thermal runaway occurs. Thermal energy shall be applied to the cell, maintaining the maximum surface end point temperature, until thermal runaway occurs or until a minimum period of 4 hours at the maximum surface temperature end point elapses.

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6.2.4 With reference to 6.2.3, the cell's exterior surface temperature shall be measured continuously through the cell test with a thermocouple junction formed from 30-gauge Type-K thermocouple wire. The location(s) of thermocouple(s) shall be determined during a construction review. At least one thermocouple is to be located below the heater film at the center of the cell surface and one near the cell terminals.

6.2.6 With reference to 6.2.3, the temperature at the onset of thermal runaway shall be documented. Onset of thermal runaway shall be determined by the point at which the rate of change of surface temperature of the cell exceeds that of the externally applied heat input. As defined in this document, thermal runaway is a condition where there is self-heating of the cell in an uncontrolled manner and should not be confused with simple overheating leading to venting. Cell venting may occur first, but it is necessary to continue heating until thermal runaway occurs.

(NEW) 7.2.13 The light transmission in the exhaust duct shall be measured using a white light source and photo detector for the duration of the test and smoke release rate calculated. See 7.2.14.

(NEW) 7.2.14 Smoke release rate shall be calculated as follows:

$$SRR = 2.303 (V/D) \log_{10} (I_o/I)$$

Where:

SRR is smoke release rate (m²/s)

V= volumetric exhaust duct flow rate (m³/s)

D = duct diameter (m)

I_o = light transmission signal of clear (pre-test) beam (volts)

I = light transmission signal during test (volts)

7.2.13 ~~15~~ Module weight loss shall be measured.

7.3.1 The report on module level testing shall include the following:

- a) Module manufacturer name and model number (and whether UL 1973 compliant);
- b) Number of cells in module;
- c) Module configuration with cells in series and parallel;
- d) Module construction features per 5.2;
- e) Module voltage corresponding to the tested SOC;
- f) Thermal runaway initiation method used including number and locations of cells for initiating thermal runaway;
- g) Heat release rate versus time data;
- h) Flammable gas generation and composition data;

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