IEC62133 (2nd edition) Safety Test Standard of Li-Ion Cell and Battery

**Insulation and wiring**

The insulation resistance between the positive terminal and externally exposed metal surfaces of the battery excluding electrical contact surfaces shall be not less than 5 MΩ at 500V DC.

**Charging methods**

**Method 1:**
- Same as 1st edition method
- Applicable to all tests except external short circuit, thermal abuse, crush and forced internal short circuit tests

**Method 2:**
- Applicable to cells and batteries subjected to the external short circuit, thermal abuse, crush and forced internal short circuit tests.
- Condition cell/battery at either the upper or lower limit charge temperature of the cell operating region for 1-4 h
- CV Charge cell/battery at the upper limit charge voltage of the cell operating region until the charging current is reduced to 0.05 I A

<table>
<thead>
<tr>
<th>Upper limit charging voltage</th>
<th>Max. charging current</th>
<th>Charging temperature upper limit</th>
<th>Charging temperature lower limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.25 V/cell</td>
<td>Specified by cell mfg</td>
<td>45°C</td>
<td>10°C</td>
</tr>
</tbody>
</table>

**8.2.1 Continuous charging at constant voltage (5 cells)**
- Continuous CV charge per mfg specifications for 7 days

**8.2.2 Moulded case stress at high ambient temperature (Moulded case battery)**

Each fully charged battery is crushed between two flat surfaces. The force for the crushing is applied by a hydraulic ram exerting a force of 13 kN ± 1 kN. The crushing is performed in a manner that will cause the most adverse result. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, the force is released. A cylindrical or prismatic cell is crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. To test both wide and narrow sides of prismatic cells, a second set of cells is tested, rotated 90° around their longitude in a axes compared to the first set.

**8.3.1 External short circuit (5 cells per temperature)**
- Using charge method 2 to fully charge cell. Each cell is then short-circuited by connecting the positive and negative terminals with a total external resistance of 80 mΩ ± 20 mΩ. The cells remain on test for 24 h or until the case temperature declines by 20% of the maximum temperature rise, whichever is the sooner.
- Test at 20 °C ± 5 °C only
8.3.2 **External short circuit (5 battery per temperature)**

- Using charge method 2 to fully charge battery. Each battery is then short-circuited by connecting the positive and negative terminals with a total external resistance of 80 mΩ ± 20 mΩ. The battery remain on test for 24 h or until the case temperature declines by 20 % of the maximum temperature rise, whichever is the sooner.
- Test at 55 °C ± 5 °C only
- In case of rapid decline in short circuit current, the battery pack remains on test an additional hour after the current reaches a low end steady state condition (e.g. battery with series connections voltage is below 0.8 V and decreasing < 0.1 V/30-minute period)

8.3.3 **Free fall (3 cells or 3 batteries)**

- Each fully charged cell or battery is dropped three times from a height of 1,0 m on to a concrete floor. The cells or batteries are dropped so as to obtain impacts in random orientations.
- Cells/Batteries are examined 1 hour after dropping

8.3.4 **Thermal abuse (5 cells)**

Each fully charged cell by charging method 2, stabilized at room temperature, is placed in a gravity or circulating air-convection oven. The oven temperature is raised at a rate of 5 °C/min ± 2°C/min to a temperature of 130°C ± 2 °C. The cell remains at this temperature for 10 min before the test is discontinued. Large cells (i.e. gross mass > 500 g) held at 130 C for 30 min.

8.3.5 **Crush (5 cells)**

Each fully charged cell by charging method 2, is crushed between two flat surfaces. The force for the crushing is applied by a hydraulic ram exerting a force of 13 kN ± 1 kN. The crushing is performed in a manner that will cause the most adverse result. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, the force is released. A cylindrical or prismatic cell is crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. To test both wide and narrow sides of prismatic cells, a second set of cells is tested, rotated 90° around their longitude in a axes compared to the first set.

Force can also be stopped when 10 % of deformation of initial dimension of cell has occurred (or when 13 kN ± 1 kN force is reached or abrupt drop of 1/3 original OCV, whichever is reached first)

- Crush only wide side of prismatic cells

8.3.6 **Over-charging of battery**

- CC charge at 2.0 I, A, using a supply voltage that does not exceed the max voltage supplied by the recommended charger or 5.0 V/cell if charger max voltage unknown
- Charging supply is sufficient to maintain 2.0 I, A throughout the duration of test or until supply voltage is reached (switch to CV charge).
- TC placed on battery surface/pack casing. Charging continued until the temperature of the outer casing reaches steady state conditions (less than 10 °C change in 30 minute period) or returns to ambient

8.3.7 **Forced discharge (5 cells)**

A discharged cell is subjected to a reverse charge at 1 It A for 90 min.

8.3.8 **Transport tests**

Tests not needed if UN transport documents are provided