### Safety or abuse tests in standards on Li-ion batteries – detailed description

This table covers safety or abuse tests for Li-ion batteries. It is made in the European projects eCaiman, Spicy and Naiades.

<table>
<thead>
<tr>
<th>Abuse Test Type</th>
<th>UL 2580:2013</th>
<th>ISO 12405-3:2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shock</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sine shock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak acceleration</td>
<td>150 gn</td>
<td></td>
</tr>
<tr>
<td>Pulse duration</td>
<td>6 milliseconds</td>
<td></td>
</tr>
<tr>
<td><strong>Thermal:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>75 ± 2 °C</td>
<td>75 ± 2 °C</td>
</tr>
<tr>
<td>Duration</td>
<td>3 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>200 Hz</td>
<td>200 Hz</td>
</tr>
<tr>
<td><strong>Temperature cycling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature range</td>
<td>-40 °C to 85 °C</td>
<td>-40 °C to 85 °C</td>
</tr>
<tr>
<td>Duration</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td><strong>Thermal shock</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak acceleration</td>
<td>50 gn</td>
<td>150 gn</td>
</tr>
<tr>
<td>Pulse duration</td>
<td>11 milliseconds</td>
<td>6 milliseconds</td>
</tr>
<tr>
<td><strong>Thermal cycling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature step</td>
<td>5 °C</td>
<td>5 °C</td>
</tr>
<tr>
<td>Duration</td>
<td>30 min or until any self heating is terminated</td>
<td>30 min or until any self heating is terminated</td>
</tr>
</tbody>
</table>

### Additional Notes
- Similar to UN38.3 but UN 38.3 says that the open circuit voltage shall not decrease by more than 10%.
- This standard says nothing about the number of similar tests.
- For battery packs and battery systems, a temperature change agreed by the customer and supplier.
- For DC-systems and 500 W/V for AC-systems.
- Battery packs and battery systems only. Test on module or higher. Nominal operating temperature and specification without any rest period in between.
- Battery packs and battery systems only. Test on module or higher. Nominal operating temperature and specification without any rest period in between.
### Electrical

- **Temperature by Connecting in Series with a 12V**
  - Each cell shall be forced discharged at ambient temperature for cells only.
- **Manufacturer's Recommended Maximum Voltage**
  - After return to 55 ± 2 °C, no leakage, rupture, fire or explosion, no disassembly, no rupture and no fire during the 6 h of observation.
- **Fire During This Test and Within the 6 h of Observation**
  - Temperature rise does not exceed 170 °C and there is no rupture, no explosion and no fire. 2:2012 says there shall be no excessive temperature does not exceed 170 °C and there is no rupture, no explosion and no fire. 2:2012 says there shall be no excessive
- **Crush**
  - A cell or component cell is to be crushed between 2 flat surfaces. Gradual crushing at 1.5 cm/s till the 6 h of observation.
- **Drop Test**
  - Place cell or battery on a flat smooth surface. Gradual crushing at 1.5 cm/s till the 6 h of observation.
- **Contact Force at Vehicle Crash**
  - The purpose is to check the functionality of the battery system with a total external resistance of less than 200 W/V.
- **Simulated Vehicle Accidents**
  - The purpose is to simulate mechanical damage to a battery system.
- **System Failure**
  - The purpose is to test the functionality of the battery system.
- **Contact Force at Acceleration**
  - The purpose is to simulate mechanical damage to a battery system.
- **Overcharge / Overvoltage**
  - The purpose is to test the functionality of the battery system.
- **Over-discharge**
  - The purpose is to test the functionality of the battery system.
- **Rotation Test**
  - The purpose is to test the functionality of the battery system.
- **Heat**
  - The purpose is to test the functionality of the battery system.
- **Electromagnetic Susceptibility**
  - The purpose is to test the functionality of the battery system.
- **System Level Protection**
  - The purpose is to test the functionality of the battery system.
- **Single Point Over Charge Protection System**
  - The purpose is to test the functionality of the battery system.
- **Single Point Over Discharge Protection**
  - The purpose is to test the functionality of the battery system.
- **Charge / Discharge**
  - The purpose is to test the functionality of the battery system.
- **Field Test**
  - The purpose is to test the functionality of the battery system.
- **Continuous Charging at Constant Voltage**
  - The purpose is to test the functionality of the battery system.
- **Discharge**
  - The purpose is to test the functionality of the battery system.
The involved institutes of this survey are:

4.3.5 Immersion Test

- Ambient temperature (20 ± 5 °C).
- Pressure of 11.6 kPa or less for at least six hours at test.

8.3 Water immersion

- For battery packs and battery systems only.

8.4 Exposure to fire

- For battery packs and battery systems only.

1.4.13 Protection against High Voltage Exposure

- Automatic disconnect failure.

Protection against Direct High Voltage Contact

- System can be safely handled in the event of vehicle high voltage system when commanded to do so.

Automatic Disconnects

- Vehicle high voltage system when commanded to do so.

Purpouse: This condition simulates a situation in which a vehicle is flooded.

Simulate a temperature / humidity environment in the vehicle shall meet the requirements of ISO 6469-3, Section 7.6.

Purpose: simulates exposure to a vehicle fire during the temperature lowering period.

Test procedure: The complete battery system is to be tested in accordance with IEC 60068-2-30 with a severity of 55°C with 6 cycles, utilizing Variant 1.

6.4.1 Test T-1: Altitude

Similar to UN38.3 but UN 38.3 says that the open circuit voltage of each test cell or battery after immediately prior to this test.

IEC 62281 ed.2:2012 says that there shall be no short-circuit during the test. Different ways of verifying the same thing.

Purpouse: This condition simulates a situation in which a vehicle is flooded.

Water immersion test

- Purpouse: This condition verifies that the battery system does not shunt (short-circuit) during any of the temperature and humidity conditions.

Heat resistance test

- Test procedure: The complete battery system is to be fully charged and isolated from an electric load. The temperature chamber and the battery shall be in operation for DC-systems and 500 W/V for AC-systems.

Isolation resistance shall be higher than 100 W/V connected to an electric load.. The temperature is to be kept constant or cooled depending on the battery system's operating temperature or until the protective control or cooling function.

Internal overheating and also a failure of thermal device activates.

The purpose is to check for internal overheating and also a failure of thermal device activates.

Internal overheating and also a failure of thermal device activates.

Protection against Direct High Voltage Contact

- System can be safely handled in the event of vehicle high voltage system when commanded to do so.

Automatic Disconnects

- Vehicle high voltage system when commanded to do so.