



# **IEC 62133:2012 (2nd Edition)**

Understanding IEC Safety Requirements for Rechargeable  
Cells & Batteries used in Portable Devices

# Guide to IEC 62133:2012 (2nd Edition)

For many portable devices that use rechargeable Lithium or Nickel based battery systems as a source of power it is now necessary for the batteries to meet the requirements of the IEC 62133:2012 standard. This includes medical devices certified to IEC 60601-1 and test equipment certified to IEC 61010-1

This guide has been written by Accutronics as a summary of the IEC 62133:2012 standard and will be useful to any individual responsible for developing or specifying a portable battery powered device.

The guide is not a replacement for the published standard and it is recommended that the full document is purchased for a complete understanding of the specific requirements.

***“2012 (2nd) edition includes a number of significant changes”***

## IEC 62133 – 1st edition v 2nd edition

IEC 62133:2012 is the second edition of this battery standard, replacing the previous 2002 edition. It carries the title of “Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications”.

The 2012 (2nd) edition includes a number of significant changes from the 1st edition, namely:

- Update of assembly of cells into batteries
- Addition of design recommendations for lithium systems only
- Separation of nickel systems and lithium systems
- Addition of specific requirements and tests for lithium systems
- Addition of charging of secondary lithium-ion cells for safe use

## Scope of the Standard

The standard specifies requirements and tests for the safe operation of portable sealed secondary cells and batteries (other than button cells) containing alkaline or other non-acid electrolytes under both intended use and reasonably foreseeable misuse.

## General Safety Conditions

Section 5 of the standard deals with the safety of secondary cells and batteries under both intended use and reasonably foreseeable misuse. Cells and batteries shall be designed and assembled so that they are safe under both of these conditions. It is accepted that cells and/



IEC 62133:2012 deals with NiCd, NiMH and Lilon cells & batteries for portable applications

or batteries subjected to misuse may fail to function but they shall not pose a significant hazard. Cells and batteries subjected to intended use shall remain safe and are usually expected to remain functional.

The standard defines potential hazards such as fire, burst/explosion, leakage of cell electrolyte, venting, burns from excessively high external temperature and rupture of the battery case with exposure of internal components.

The following seven areas are checked by inspection and by the specific requirements for either Nickel or Lithium based systems:

### • Insulation and wiring

The standard requires that insulation resistance between the positive terminal of the battery and any externally exposed metal surfaces (excluding electrical contacts) is not less than 5MΩ at 500VDC. Internal wiring and its insulation shall be rated to withstand the maximum voltage, current and temperature

requirements of the battery. Adequate clearances and creepage distances shall be maintained and the mechanical integrity of internal electrical connections shall be sufficient to accommodate the conditions of the foreseeable misuse tests.

## ***“The standard defines potential hazards”***

### • Venting

The standard requires that cells and battery cases incorporate a pressure relief mechanism or be constructed so that they will relieve excessive internal pressure so as to prevent rupture, explosion and self-ignition. If encapsulate materials are used to support cells within a battery then the type of encapsulate and its location must not cause a battery to overheat during normal use or prevent the activation of pressure relief devices.



Section 7 of the standard deals with specific tests for both Nickel Cadmium and Nickel Metal Hydride cells and batteries

***“Cells used in multi-cell batteries shall have matched capacities, be the same design & chemistry & from the same manufacturer”***

#### • Temperature / Voltage / Current Management

The standard requires that batteries are designed so that abnormal temperature rise conditions are prevented. Batteries shall be designed within temperature, voltage and current limits which are defined by the cell manufacturer. Specifications for the batteries shall be provided to equipment manufacturers so that chargers are designed to charge within the specified voltage, current and temperature limits. The standard notes that where necessary, means can be provided to limit current to safe levels during both charge and discharge.

#### • Terminal Contacts

The standard requires that the external electrical terminals on batteries shall be clearly marked with polarity symbols unless the battery has keyed external connectors which ensure they can only be used with a specific product and which prevents reverse connection. Electrical terminals shall be designed to have sufficient mechanical strength and corrosion resistance and should be arranged to minimise the risk of short circuit.

#### • Assembly of Cells into Batteries

The standard states that cells used in the assembly of multi-cell batteries shall have matched capacities, be of the same design and chemistry and be from the same manufacturer. Each battery shall have independent control and protection. The battery manufacturer shall use the recommendations from the cell manufacturer with regards to voltage, current and temperature limits to ensure proper design and assembly. Protective circuit components should be added as required, taking into consideration the requirements of the end device application. The manufacturer of the battery shall provide a test report confirming compliance to this standard.

#### • Design Recommendations for Lithium Systems Only

The standard describes how the voltage of single cells or cells within batteries made from multiple cells (in series and parallel) should not have their upper charging voltage exceeded. If the battery consists of multiple cells in series then the individual series cells (or parallel groups of cells) shall be monitored. Charging should be stopped if one or more series cells exceeds the upper limit. The standard defines the limit as 4.25V but acknowledges that this may be modified if dictated by a specific cell chemistry.

#### • Quality Plan

The standard requires the manufacturer (of both cells and batteries) prepare and implement a quality plan which defines procedures for the inspection

of materials, components, cells and batteries. The plan should also cover the process of producing each cell or battery. Process controls should be implemented to ensure product safety.

### Type Test Conditions

The standard requires that tests are performed on specific numbers of cells or batteries. The numbers and types of test are different depending on the chemistry. Cells or batteries must not be more than 6 months old. All tests are conducted at +20°C unless otherwise specified.

### Specific Requirements and Tests for Nickel Systems

Section 7 of the standard describes the specific tests that shall be conducted on both Nickel Cadmium and Nickel Metal Hydride cells and batteries. The standard highlights the fact that these tests use procedures which may result in harm if adequate precautions are not taken. The tests should only be conducted by qualified and experienced technicians using adequate protection.

#### • Charging Procedure for Test Purposes

The standard describes that unless otherwise stated the charging should be conducted at +20°C using a method described by the manufacturer. Prior to charging, the cell or battery should be discharged at 0.2C to an end of discharge voltage specified by the manufacturer.

#### • Intended Use – Continuous Low Rate Charging (Cells Only)

The standard states that continuous low rate charging shall not cause a fire or explosion. This is tested by charging already fully charged cells for a further 28 days at a charge rate specified by the manufacturer. There shall be no fire or explosion.

#### • Intended use – Vibration (Cells or Batteries)

The standard states that vibration encountered during transportation shall not cause leakage, fire or explosion. This is tested by subjecting fully charged cells or batteries to a simple harmonic motion with an amplitude of 0.76mm and a total maximum excursion of 1.52mm. The frequency is varied at the rate of 1Hz per minute between 10Hz and 55Hz. The entire range is traversed in 90 minutes. The 90 minute test is conducted in

each of three mutually perpendicular directions. The cell or battery is visually inspected 1 hour after the test. There shall be no fire, explosion or leakage.

- **Intended Use - Moulded Case Stress at High Ambient Temperature (Batteries Only)**

The standard states that the internal components of batteries shall not be exposed during use at high temperatures. This is tested by subjecting fully charged batteries to a temperature of +70°C for 7 hours. After this time the batteries are removed and allowed to return to room temperature. There shall be no physical distortion of the battery case which results in exposure of internal components.

- **Intended Use – Temperature Cycling (Cells or Batteries)**

The standard states that repeated exposure to high and low temperatures shall not cause fire or explosion. This is tested by subjecting fully charged cells or batteries to an ambient temperature of +75°C for 5 hours, followed by +20°C for 2 hours, followed by -20°C for 4 hours, followed by +20°C for 2 hours. The maximum rise or fall time between test temperatures shall be 30 minutes. The sequence shall be repeated a further 4 times (5 cycles in all). After the fifth cycle the cells or batteries shall be stored and monitored for a minimum of 24 hours. There shall be no fire, explosion or leakage.

- **Reasonably Foreseeable Misuse - Incorrect Installation (Cells Only)**

The standard states that incorrect installation of a single cell in a multi-cell application shall not cause a fire or explosion. This is tested using four fully charged cells and building a four series battery where one of the cells is reversed. The four cell assembly is connected across a 1Ω resistor until the vent of the reversed cell opens or until its temperature returns to ambient. There shall be no fire or explosion.

- **Reasonably Foreseeable Misuse – External Short Circuit (Cells or Batteries)**

The standard states that the short circuiting of the positive and negative terminals shall not cause a fire or explosion. This is tested by storing two sets of cells or batteries at ambient temperature of +20°C and +55°C respectively. The positive and negative terminals of the cells or batteries are then short circuited with a total external resistance of 80mΩ. They are then



The standard requires that batteries be designed to prevent abnormal temperature rise conditions

rested for 24 hours (or until the case temperature falls by 20% from its maximum value). There shall be no fire and no explosion.

***“The tests should only be conducted by qualified & experienced technicians”***

- **Reasonably Foreseeable Misuse – Free Fall (Cells or Batteries)**

The standard states that dropping a cell or battery shall not cause a fire or explosion. This is tested by dropping fully charged cells or batteries three times from a height of 1 metre onto a concrete floor. The drop shall be made as to create impact in random orientations. After the test the cells or batteries shall be rested for a minimum of one hour before a visual inspection is conducted. There shall be no fire or explosion.

- **Reasonably Foreseeable Misuse – Mechanical Shock (Cells or Batteries)**

The standard states that shocks encountered during handling or transportation shall not cause a fire, explosion or leakage. This is tested by subjecting fully charged cells or batteries to a total of three shocks of equal magnitude at +20°C. The shocks are applied in each of three mutually perpendicular directions. At least one shall be perpendicular to a flat face. Each

shock shall accelerate the cell or battery to 75g within 3ms. The peak acceleration shall be between 125g and 175g. After the test the cells or batteries shall be rested for a minimum of one hour before a visual inspection is conducted. There shall be no fire, explosion or leakage.

- **Reasonably Foreseeable Misuse – Thermal Abuse (Cells Only)**

The standard states that an extremely high temperature shall not cause fire or explosion. This is tested by subjecting fully charged cells to an increasing temperature, starting at room temperature and increasing to +130°C at a rate of 5°C per minute. The temperature of +130°C shall be maintained for 10 minutes before the test is stopped. There shall be no fire or explosion.

- **Reasonably Foreseeable Misuse – Crushing (Cells Only)**

The standard states that the crushing of a cell shall not cause a fire or explosion. This is tested by crushing fully charged cells between two flat surfaces. The force applied shall be 13kN. 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. If prismatic cells are being tested then a second set, rotated through 90° shall also be tested. There shall be no fire or explosion.

• **Reasonably Foreseeable Misuse – Low Pressure (Cells Only)**

The standard states that low pressure shall not cause fire or explosion. This test is designed to simulate low pressures that may be experienced in the cargo compartment of an aircraft. This is tested by placing fully charged cells into a vacuum chamber in an ambient temperature of +20°C. The pressure is then reduced to a pressure of 11.6kPa which simulates an altitude of 15,240m. The pressure is maintained for 6 hours. There shall be no fire, explosion or leakage.

• **Reasonably Foreseeable Misuse – Overcharge (Cells or Batteries)**

The standard states that charging for longer periods and at a higher rate than specified by the manufacturer shall not cause a fire or explosion. This is tested by subjecting previously discharged cells or batteries to a high-rate charge 2.5 times the recommended charging current for a time that produces an input which is 250% of the rated capacity. There shall be no fire or explosion.

• **Reasonably Foreseeable Misuse – Forced Discharge (Cells Only)**

The standard states that a cell in a multi-cell application shall withstand polarity reversal without causing fire or explosion. This is tested by reverse charging a previously discharged cell at 1C for 90 minutes. There shall be no fire or explosion.

***“The standard defines requirements & tests for lithium systems”***

**Specific Requirements & Tests for Lithium Systems**

Section 8 of the standard describes the specific tests that shall be conducted on lithium cells and batteries. The standard highlights the fact that these tests use procedures which may result in harm if adequate precautions are not taken. The tests should only be conducted by qualified and experienced technicians using adequate protection.

• **Charging Procedure for Test Purposes**

The standard defines two methods of charging, termed ‘first procedure’ and ‘second procedure’.

**First Procedure**

The standard describes that unless otherwise stated, charging should be conducted at +20°C using a method described by the manufacturer. Prior to charging, the cell or battery should be discharged at 0.2C to an end of discharge voltage specified by the manufacturer.

**Second Procedure**

This procedure applies only to the following reasonably foreseeable misuse tests: ‘External Short Circuit (Cells Only)’, ‘External Short Circuit (Batteries Only)’, ‘Thermal Abuse (Cells Only)’, ‘Crush (Cells Only)’ and ‘Forced Internal Short Circuit (Cells Only)’.

The standard describes that cells or batteries are stabilised for between 1 hour and 4 hours at either a ‘high test temperature’ of +45°C or a ‘low test temperature’ of +10°C before being charged using a constant voltage technique at the ‘upper limited charging voltage’ and the ‘maximum charging current’ until the current is reduced to 0.05C. If the manufacturer of the cell specifies that the cell may be charged at temperatures exceeding the upper and lower test temperatures then the cell shall be charged and if applicable tested at the specified values plus 5°C for the upper limit and minus 5°C for the lower limit.

The standard states that in the case of different upper limit charging voltage (i.e. systems other than cobalt oxide systems at 4.25V) it can be appropriate to adjust

the upper limit charging voltage and temperatures to fulfil the criteria of the tests that require this second charging procedure.

• **Intended Use – Continuous Charging at Constant Voltage (Cells Only)**

The standard states that a continuous charge at constant voltage shall not cause a fire or explosion. This is tested by charging previously fully charged cells for a further 7 days at a charge specified by the manufacturer. There shall be no fire, explosion or leakage.

• **Intended Use - Moulded Case Stress at High Ambient Temperature (Batteries Only)**

The standard states that the internal components of batteries shall not be exposed during use at high temperatures. This is tested by first charging batteries using the ‘first procedure’ before placing them in an oven which is set to a temperature of +70°C. After 7 hours the batteries are removed and allowed to return to room temperature. There shall be no physical distortion of the battery case which results in exposure of internal components.

• **Reasonably Foreseeable Misuse – External Short Circuit (Cells Only)**

The standard states that the short circuiting of the positive and negative terminals of a cell at ambient temperature shall not cause a fire or explosion. This is tested by first charging cells in accordance with the ‘second procedure’.



Forced internal short circuit tests introduced for Lithium cells following well documented safety incidents

The positive and negative terminals are then short circuited with a total external resistance of 80mΩ. They are then rested for 24 hours (or until the case temperature falls by 20% from its maximum value). There shall be no fire and no explosion.

**• Reasonably Foreseeable Misuse – External Short Circuit (Batteries Only)**

The standard states that the short circuiting of the positive and negative terminals of a battery pack shall not cause fire or explosion. This is tested by first charging each battery pack in accordance with the 'second procedure' before storing them in an ambient of +55°C. The positive and negative terminals are then short circuited with a total external resistance of 80mΩ. They are then rested for 24 hours (or until the case temperature falls by 20% from its maximum value). In the case of a rapid decline in short circuit current the battery should remain on test for an additional 1 hour after the current reaches a low end steady state condition. There shall be no fire and no explosion.

**• Reasonably Foreseeable Misuse – Free Fall (Cells or Batteries)**

The standard states that dropping a cell or battery shall not cause a fire or explosion. This is tested by dropping fully charged cells or batteries (that have been charged using the 'first procedure') three times from a height of 1 metre onto a concrete floor. The drop shall be made as

to create impact in random orientations. After the test the cells or batteries shall be rested for a minimum of one hour before a visual inspection is conducted. There shall be no fire or explosion.

**• Reasonably Foreseeable Misuse – Thermal Abuse (Cells Only)**

The standard states that an extremely high temperature shall not cause fire or explosion. This is tested by subjecting fully charged cells (that have been charged using the 'second procedure') to an increasing temperature, starting at room temperature and increasing to +130°C at a rate of 5°C per minute. The temperature of +130°C shall be maintained for 10 minutes (30 minutes for larger cells) before the test is stopped. There shall be no fire or explosion.

**• Reasonably Foreseeable Misuse – Crushing (Cells Only)**

The standard states that the crushing of a cell shall not cause a fire or explosion. This is tested by first charging cells in accordance with 'second procedure' at the higher temperature limit. The cells are then immediately crushed between two flat surfaces. The force applied shall be 13kN. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, or a 10% deformation has occurred compared to the initial dimension then the force is released. Unlike the test for nickel systems, prismatic cells are only tested with the

crushing force applied to their wide side. There shall be no fire or explosion.

**• Reasonably Foreseeable Misuse – Over-Charging of Battery (Batteries Only)**

The standard states that charging for longer periods than specified by the manufacturer shall not cause a fire or explosion. This is tested by charging a previously discharged battery at a constant current of 2C up to a voltage equal to that which would be supplied by the recommended charger. A thermocouple shall be attached to the case of the battery during the test. The test shall continue until the temperature of the outer case reaches a steady state (<10°C change in 30 minutes) or returns to ambient. There shall be no fire or explosion.

**• Reasonably Foreseeable Misuse – Forced Discharge (Cells Only)**

The standard states that a cell in a multi-cell application shall withstand polarity reversal without causing fire or explosion. This is tested by reverse charging a previously discharged cell at 1C for 90 minutes. There shall be no fire or explosion.

**• Reasonably Foreseeable Misuse – Transportation**

The manufacturer of the battery shall provide documentation to demonstrate compliance with the testing requirements as defined in the UN Manual of Tests and Criteria.



• **Reasonably Foreseeable Misuse – Forced Internal Short Circuit (Cells Only)**

The standard states that a forced internal short circuit test for cylindrical and prismatic cells shall not cause a fire. This is a country specific test which is only applicable to France, Japan, Korea and Switzerland. The test is not required for polymer (pouch) cells.

This is tested by the cell manufacturer or a third party and involves the introduction of a nickel particle into the internal electrode windings of the cell. For full details please refer to the standard.

### Information for Safety

The standard states that the use, and particular abuse, of portable sealed rechargeable secondary cells and batteries containing alkaline or other non-acid electrolytes may result in the creation of hazards and may cause harm. The manufacturers of cells shall provide battery manufacturers with information relating to the specific limits for temperature, voltage and current. Manufacturers of batteries shall ensure that their customers (usually device manufacturers) are provided with information to minimise and mitigate hazards.

The standard states that it is the equipment manufacturers' responsibility to inform end users of the potential hazards arising from the use of equipment

containing secondary cells and batteries. Device manufacturers should perform a systems analysis to ensure a particular battery design prevents hazards from occurring during the use of a product. Any information relating to hazard avoidance resulting from a system analysis should be provided to the end user.

Conformity shall be checked by examination of manufacturers' documentation.

### Marking

• **Marking (Cells)**

The standard states that cells shall be marked in accordance with one of the following standards:

IEC 61951-1 (Secondary cells and batteries containing alkaline or other non-acid electrolytes - Portable sealed rechargeable single cells - Part 1: Nickel-cadmium)

IEC 61951-2 (Secondary cells and batteries containing alkaline or other non-acid electrolytes - Portable sealed rechargeable single cells - Part 2: Nickel-metal hydride)

IEC 61960 (Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications).

The standard notes that cells need not be marked if agreed between the cell manufacturer and the battery manufacturer.

• **Marking (Batteries)**

The standard states that batteries shall be marked in accordance with the requirements for the cells from which they are assembled. Batteries shall also be marked with an appropriate caution statement. Conformity is checked by inspection.

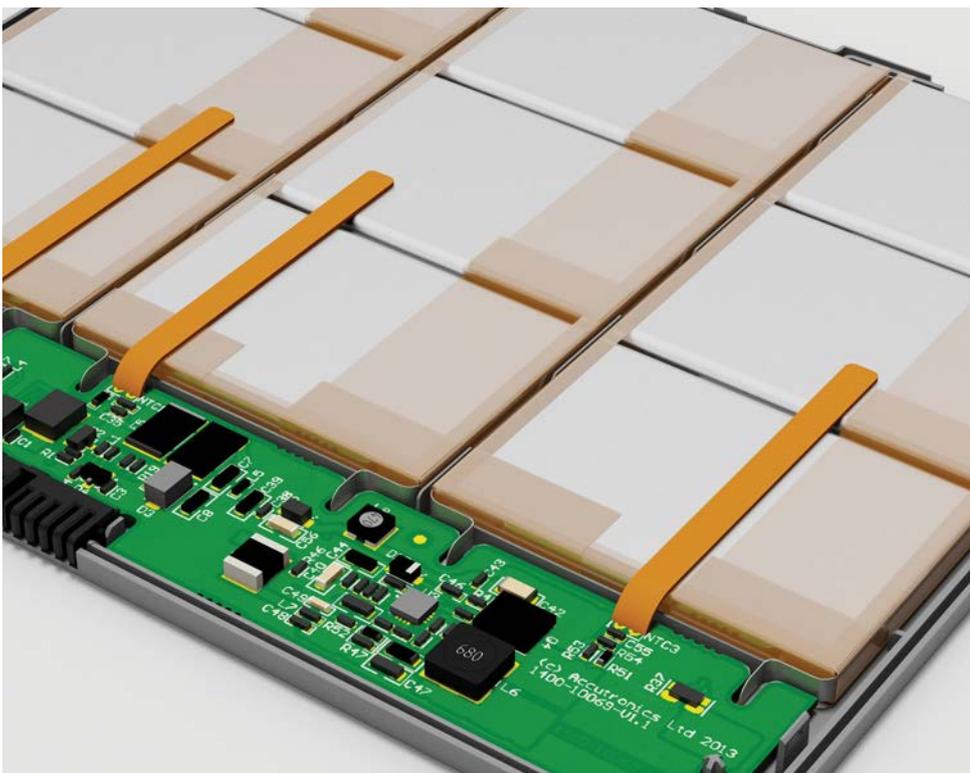
• **Marking - Other information**

The standard states that batteries shall be marked or supplied with (i) storage and disposal instructions (ii) recommended charging instructions.

***“Manufacturers should provide document(s) for UN Manual of Tests & Criteria”***

### Packaging

The standard states that the goal of packaging for secondary cells and batteries is to prevent the opportunities for short circuit, mechanical damage and the possible ingress of moisture. The standard does not however provide further details regarding how packaging should be designed or manufactured.



### Further Information

Accutronics is an industry leader in the design, development & manufacture of batteries & chargers for applications where power failure is not an option, creating high quality, high performance solutions that meet demanding application requirements.

OEMs worldwide depend on us to deliver both custom and pre-engineered solutions which are differentiated by innovation, time to market, performance, reliability & safety.

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