Technical Guidance for the application of the 30% state of charge limitation (SoC)

For the transport of Li-ion batteries by air

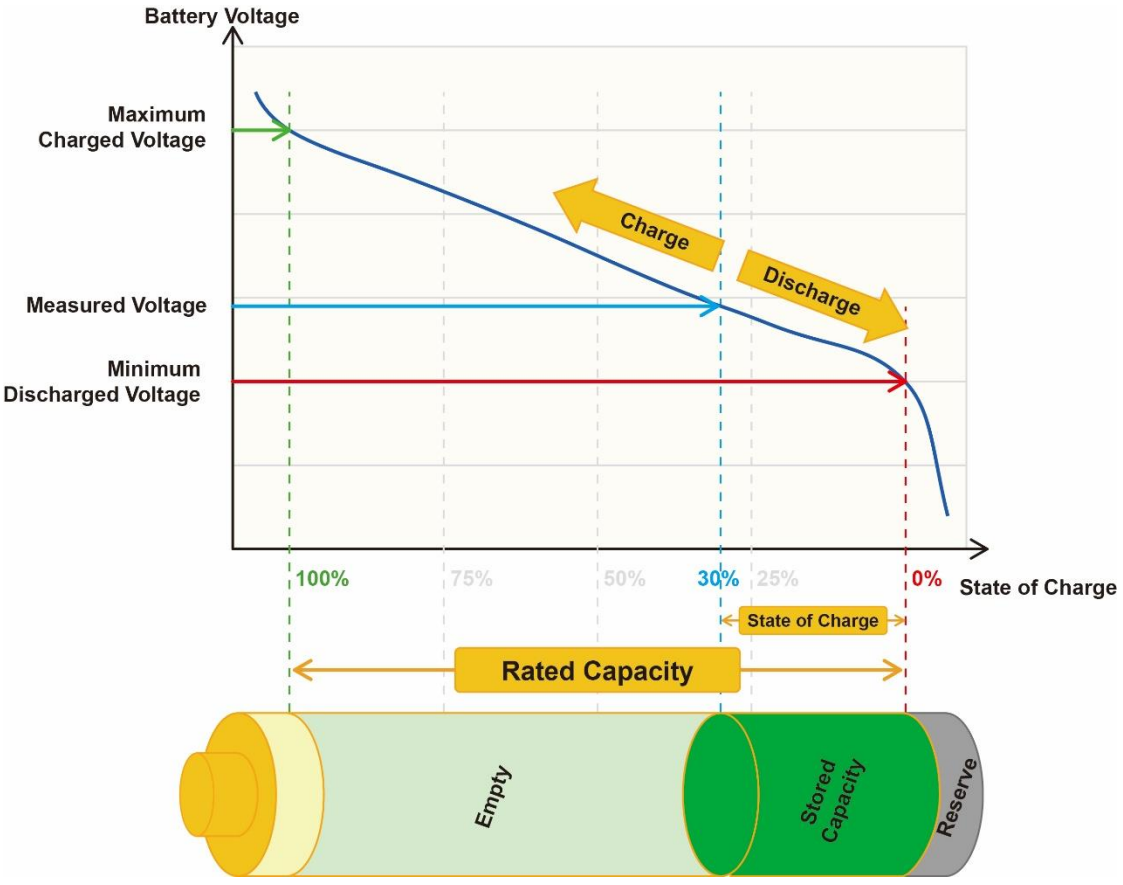
This document is based on the provisions set out in the 2025-2026 Edition of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air (Technical Instructions) and the 66th Edition (2025) of the IATA Dangerous Goods Regulations (DGR).

The ICAO regulation requires a controlled state of charge (SoC) at 30% or less for the shipment of Li-ion batteries by air (UN 3480). This limitation is not applicable to batteries contained in or packed with equipment (UN 3481). Prior to becoming mandatory on 1 January 2026, it is strongly encouraged that the state of charge of the batteries be reduced to below 30% SoC (or 25% indicated battery capacity) before packing. This SoC information shall be available for customers, enforcement agencies, freight forwarders, airlines and other entities upon request.

What means SoC?

The SoC is the available capacity stored in a battery, expressed as a percentage of the rated capacity (see definitions in annex 2).

The graph below shows the relation between the battery voltage curve, the rated capacity, and the SoC.



How to know the Rated capacity?

It is provided by the manufacturer, based on the maximum charged voltage and the minimum discharged voltage corresponding to each battery chemistry. The value of the rated capacity is depending on these voltage limits, but also on the measurement conditions. In order to obtain reproducible results, these conditions have to be specified (current, temperature, maximum and minimum voltage, resting time,…). Standard conditions to measure the rated capacity are provided in IEC standards (see references in annex 1).

How to set the state of charge (SoC)?

The value of the state of charge depends on the last charge or discharge process of the battery (either during manufacturing, control, or usage of the battery). For new batteries, the SoC is fixed by the last step of the manufacturing process, which can be used to fix the batteries SoC at 30%. The values for the rated capacity and the SoC provided by the manufacturer are generally measured in standard or equivalent conditions.

Methods to measure the SoC

Two main methods can be used to measure the SoC of a battery. They also can be used in combination.

1. **The voltage measurement.**

A voltage measurement can give an indication about the SoC (see figure), particularly when measured in open circuit voltage condition. Compared to the voltage curve in specific conditions, it can be used to assess the battery SoC. This method requires technical precautions, as the result depends on the environmental conditions (temperature, rest time,…), and the knowledge of the voltage curve, specific to each chemistry.

Some battery chemistries have a voltage curve with almost no slope. In this case this method cannot be used alone.

2. **The coulometric measurement.**

The direct measure of the capacity during a full discharge of the battery provides the SoC information, when compared to the rated capacity. As in the case of the rated capacity measurement, this method requires specific equipment to control the battery discharge conditions and measure the current (see reference documents in annex 2 for standard conditions).

3. **Combined voltage and coulometric measurement.**

Most of the SoC gauges implemented on batteries are based on some kind of combination of the above methods, with possible additive features taking in account the battery impedance, ageing, temperature, resting time, etc..

Practical solutions to implement the 30% SoC control.

It has been recognized that the reduction of SoC from 100% to 30% SoC reduces significantly the hazards of Li-ion batteries. Although no accuracy for the SoC has been specified in the regulation, it can be admitted that an accuracy in the range of a few percent is fulfilling the requirement of the control regulation.

The shipper should seek by order of priority the following information to control the SoC, before offering the batteries for transport:

- **The information provided by the original battery manufacturer**. This is applicable particularly in case of new batteries, where the manufacturer can set the 30%SoC during his manufacturing process. The SoC control is based on the manufacturer self-certification of compliance with the regulations, as for other processes applicable for dangerous goods shipments.

- In case the SoC of the batteries is unknown, the gauges provided by the manufacturer can be used to estimate it, when available. The SoC assessment requires some technical precautions, such as:

    - A statistical sampling plan, to ensure the SoC homogeneity of all the shipped batteries.
    - An assessment of the accuracy of the gauges, based on the gauge manufacturer technical information.

- In absence of information and gauges, measurement procedures should be set up. In case the batteries SoC has to be modified and reset at 30%, a charge/discharge equipment would be required. Both operations require technical capabilities and competences and should only be applied with the support or agreement of the battery manufacturer. The company operating a modification of the batteries SoC endorses the responsibility of the SoC compliance.

Annex 1: reference documents

Over the years lithium batteries have become more heavily regulated as they're used in various electric devices and wider fields of application globally. The safety and reliability of lithium batteries is therefore governed by various international standards.

One of these standards is Regulation UN 38.3. Classified as a class-9 dangerous goods by the United Nations, batteries need to meet requirements specified in UN 38.3 Regulation which details the specifics that must be fulfilled to safely transport lithium cells and batteries (by air, sea, land). The standard, which is recognised by regulators and custom authorities around the world, is also seen as an important gateway to access global markets. From a technical perspective, UN 38.3 testing can be performed on cell, module or pack level and represents a combination of rigorous mechanical, electrical and most importantly environmental exposures designed to assess a battery's stability during transportation.

In addition to UN 38.3, there are safety standards such as IEC 61960, IEC 62133 and IEC 62660-1

To assist shippers in understanding the complete requirements related to the transport of batteries including lithium and sodium ion batteries, IATA has prepared an updated Battery guidance document (pdf).

Annex 2: Definitions

Proposed definitions are based on the UN Manual of tests and criteria
https://unece.org/about-manual-tests-and-criteria

Nominal energy or Watt-hour rating, expressed in watt-hours, means the energy value of a cell or battery determined under specified conditions and declared by the manufacturer. The nominal energy is calculated by multiplying **nominal voltage** by **rated capacity** expressed in ampere-hours.

Nominal voltage means the approximate value of the voltage used to designate or identify a cell or battery.

Open circuit voltage means the voltage across the terminals of a cell or battery when no external current is flowing.

Rated capacity means the capacity, in ampere-hours or milliampere-hours, of a cell or battery as measured by subjecting it to a load, temperature and voltage cut-off points specified by the manufacturer.

State of charge (SoC) means the available capacity stored in a battery, expressed as a percentage of the **rated capacity.**