

## Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

24 June 2024

Sixty-fourth session

Geneva, 24 June-3 July 2024

Item 4 (a) of the provisional agenda

Electric storage systems:

Testing of lithium batteries

### UN 38.3 Lithium battery test rupture definition

Transmitted by The Rechargeable Battery Association (PRBA)

#### I. Introduction

1. **The intent of this informal document is to improve upon Working Document ST/SG/AC.10/C.3/2024/57 – UN 38.3 Lithium battery test rupture definition. Changes are marked in bold characters.**

2. According to the *Manual of Tests and Criteria*, section 38.3.2.3 defines “rupture” as “the mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage but not ejection of solid materials”.

3. There is uncertainty about the interpretation of the word “exposure” in the definition of rupture, particularly for a battery with a casing that has visual exposure to the cells by design.

4. Large format battery assemblies typically use component batteries (e.g., modules), which by design use plastic and metal frames to hold the battery together **physically but** may not necessarily fully encase the battery **meaning there is** visual exposure before UN 38.3 tests begin. These exposed battery designs are then subjected to the UN 38.3 lithium battery tests. It is therefore unclear how to apply the exposure term in the rupture definition for a battery that by design already exposes **internal components** of the battery. **If there is a bend in the battery frame, which may create more visual exposure, is this considered a failure?**

5. For batteries **fully enclosed by casings**, there is a general consensus within the industry that mechanical failure of **the casing** that results in visual exposure of the internal components of the battery case would be interpreted as a rupture (**reference Appendix Figure 1**). **Likewise, a battery full enclosed by its casings that bulges or flexes from expansion but does not break and does not visually expose the internal component would be considered a “no rupture” event (reference Appendix Figure 2). However, for a battery not fully enclosed by its casing (reference Appendix, Figures 3, 4 and 5), when a cover bulges or flexes from expansion, the already exposed internal battery components will be more exposed visually and it is unclear if this additional exposure would be interpreted as a rupture or not.**

6. Reviewing other definitions in 38.3.2.3, it is clear “leakage means the visible escape electrolyte or other materials”. While “venting means the release of excessive internal pressure”. The term leakage appears to cover liquids, while venting appears to cover gases. The definition of rupture includes “spillage of solid materials” but should it be assumed exposure is applicable to only “solid materials” (e.g., resulting in exposure [of solid materials] or spillage but not ejection of sold materials)?

7. **Reviewing definitions from other industry standards (reference Appendix) for rupture, there are multiple interpretations of this term across standards, and they are not uniform definitions. Some use a physical test such as a “finger” test to measure the amount of exposure. Others include references to expulsion of gas and spilling of liquids.**

**These different definitions create further confusion trying to interpret the definition a UN 38.3 rupture for batteries which are not fully enclosed by their casings.**

8. The definition of disassembly includes the term rupture: “Disassembly means a rupture of the cell or battery case where solid components are ejected”. Tests T.1 through T.5 have requirements for “No Rupture” and “No Disassembly”. This appears redundant in that you **cannot** have “Disassembly” without “Rupture”. So, it is not necessary to have a requirement for “No Disassembly” whenever “No Rupture” is already listed.

9. Tests T.6 (Crush/Impact), T.7 (Overcharge), and T.8 (Forced Discharge) are all external abuse events to the cell or battery. The requirements for these tests do not include “No Rupture”, but instead only requires “No Disassembly” and “No Fire”. Test T.5 is very similar to tests T.6, T.7, and T.8 in that it is an external abuse condition applied to the battery. It seems that T.5 should follow the same requirements as T.6, T.7, and T.8 and not use rupture, but merely reference disassembly due to the abusive nature of this test.

10. PRBA therefore proposes a change to the definition of rupture in 38.3.2.3 and modification to the T.1 through T.5 requirements to remove the redundant disassembly requirement when rupture is already required and to align T.5 requirements with similar T.6, T.7, and T.8 tests.

## II. Proposal

11. The Sub-Committee is invited to amend 38.3.2.3 definition of rupture and the requirements listed in 38.3.4.1.3, 38.3.4.2.3, 38.3.4.3.3, 38.3.4.4.3, 38.3.4.5.3 as follows (new text is underlined, deleted text in ~~strike through~~):

12. “Rupture means the mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure of solid materials or spillage but not ejection of solid materials. In the case of batteries that are not fully enclosed by their casings, and are exposed to the tests in subsection 38.3 by design, rupture means the mechanical failure of the battery case induced by an internal or external cause, resulting in spillage but not ejection of solid materials.”

13. “38.3.4.1.3 Requirement

Cells and batteries meet this requirement if there is no leakage, no venting, ~~no disassembly~~, no rupture with or without disassembly, and no fire...”

14. “38.3.4.2.3 Requirement

Cells and batteries meet this requirement if there is no leakage, no venting, ~~no disassembly~~, no rupture with or without disassembly, and no fire...”

15. “38.3.4.3.3 Requirement

Cells and batteries meet this requirement if there is no leakage, no venting, ~~no disassembly~~, no rupture with or without disassembly, and no fire...”

16. “38.3.4.4.3 Requirement

Cells and batteries meet this requirement if there is no leakage, no venting, ~~no disassembly~~, no rupture with or without disassembly, and no fire...”

17. “38.3.4.5.3 Requirement

Cells and batteries meet this requirement if their external temperature does not exceed 170 °C and there is no rupture with disassembly, ~~no rupture~~ and no fire during the test and within six hours after the test.”

18. **38.3.4.6.4 Requirement**

**Cells and component cells meet this requirement if their external temperature does not exceed 170 °C and there is no rupture with disassembly and no fire during the test and within six hours after this test.**

19. **38.3.4.7.3 Requirement**

Rechargeable batteries meet this requirement if there is no rupture with disassembly and no fire during the test and within seven days after the test.

20. 38.3.4.8.3 Requirement

Primary or rechargeable cells meet this requirement if there is no rupture with disassembly and no fire during the test and within seven days after the test.

## Appendix

Reference definitions of Rupture from various battery industry standards:

**UN ECE R100:** Rupture means opening(s) through the casing of any functional cell assembly created or enlarged by an event, large enough for a 12mm diameter test finger (IPXXB) to penetrate and make contact with live parts.

**ISO 1649-1:** loss of mechanical integrity of an enclosure resulting in openings not fulfilling protection degree IPXXB according to ISO 20653

**IEC 62281:** A rupture is considered to have occurred if a cell container or battery case has mechanically failed, resulting in expulsion of gas or spillage of liquids but not forcible ejection of solid materials

**IEC 62133:** mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage but not ejection of materials. It should be noted that IEC 62133 appears to provide an exception for rupture “exposure” in 7.2.2 Case stress at high ambient temperature (battery). The exception would appear to exempt battery designs not fully enclosed by its casings:

7.2.2.a) Requirement: Internal components of batteries shall not be exposed during use at high temperature. This requirement only applies to batteries with a moulded case.

**ANSI C18.3:** a mechanical failure of a cell container or battery case, resulting in an expulsion of gas or spillage of liquids but not ejection of solid materials.

Example Photos



Figure 1

Battery with bulging resulting in internal cells exposed meets definition of rupture.



Figure 2

Battery with bulging (no cells exposed) would not meet definition of rupture



Figure 3

Example Battery Module with cells exposed by design



Figure 4

2nd Example Battery Module with cells exposed by design



Figure 5

3rd Example Battery Module with cells exposed by design