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UN 38.3 TRANSPORT TESTS FOR LITHIUM CELLS AND BATTERIES - CHANGES IN REQUIREMENTS EFFECTIVE IN JANUARY 2013

The so called "UN Transport Tests" form the basis for many if not all regulations regarding the transportation of lithium cells or batteries. Only if the required set of tests has been passed and if some further requirements are fulfilled (especially for air transport further restrictions apply) the lithium cells or batteries may be offered for transport without the precautions otherwise required for the transportation of dangerous goods. Here is a look at the latest amendments to section 38.3 of the "Recommendation on the transport of dangerous goods, Manual of Test and Criteria" (UN ST/SG/AC.10/11).

With the increasing importance of lithium based energy storage for everyday life applications as well as for e-mobility, the importance of the UN Transport Tests is destined to increase as well. The tests are specified in section 38.3 of the "Recommendation on the transport of dangerous goods, Manual of Test and Criteria" (UN ST/SG/AC.10/11). The currently effective revision is Rev 5. An amendment to Rev 5 (Amd 1) has already been published. This is destined to become effective in January 2013 without further changes in section 38.3.

With the Rev 5 Amd 1 some of the requirements for lithium cells and batteries will change. Most notably the requirement for a re-test has been somewhat relaxed, a break off from the housing during a test does not necessarily constitute a failure anymore, component cells need to also pass T.8, the thermal test has been relaxed (from 75 °C to 72 °C), the vibration test has been relaxed for large batteries (2 g_n instead of 8 g_n) and a new Crush Test replaces the Impact Test for most cell types. A number of more subtle changes have been made that, while seeming unimportant to many, may well have an impact on some products. The following points are a selection of the changes in the new revision, given in the sequence of their appearance in the specification (not weighted for their supposed importance). The changed requirements are written in *italics*:



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Scope

Section 38.3 now starts with a summary of which type of primary/secondary cell/battery shall be subjected to which tests. While it does not contain requirements that are not also listed elsewhere, the new overview makes things much clearer.

When is a re-test required?

If cells or batteries differ from a tested type by: [...]

- Old: (c) A change that would materially affect the test results.
- *New: (c) A change that would lead to failure of any of the tests.*

A foreseeable small influence on the test results is not a criterion for a re-test anymore. Only if a failure of at least one of the tests seems possible a re-test is required. A list of examples of changes that may lead to a re-test is given.

Definition of Battery

- Old: Battery means one or more cells ...
- *New: Battery means two or more cells ...*

A long running source of confusion has been clarified. A one cell battery shall be regarded and tested as a cell not as a battery. Although a rechargeable single cell battery with overcharge protection shall additionally be subjected to T.7 which is otherwise reserved to rechargeable batteries (not cells).

Definition of Large/Small Cell:

- Old (large): For lithium metal cell if lithium content of the anode, when fully charged, is more than 12 g. For lithium ion cell if the watt-hour rating is more than 150 Wh. Otherwise the cell is small.
- *New (large): If gross mass is more than 500 g. Otherwise the cell is small.*

Similar to the change of the definition for a large/small battery between Rev 4 and Rev 5 the definition of a large/small cell now refers to the gross mass and gives an easier to handle criterion.

Definition of Leakage:

Old: the escape of material from a cell or battery.

New: the visible escape of electrolyte or other material from a cell or battery or the loss of material (except battery casing, handling devices or labels) from a cell or battery such that the loss of mass exceeds the values in Table 38.3.1.

Noteworthy are the listed exceptions. A break off from the battery casing is not necessarily a failure criterion anymore (it may still be a disassembly or rupture and thus a failure though). Care must be taken that any broken or fallen off parts are collected and assigned to the individual sample where they came from, before the latter are weighed to determine the mass loss. Another rare but real exception would be that a battery releases enough moisture from its plastic or foam rubber housing during the thermal test (T.2) to fail the mass loss limit. Since this is not leakage anymore, it is no longer a failure criterion. However, it will be up to the manufacturer to prove that the mass loss originates from the housing and not from another part of the battery. It would probably be an open question to which extent a foam rubber layer inside a plastic housing is to be regarded as part of the battery casing or not.

Mass loss limit

The mass loss limit has been relaxed for cells or batteries with a mass $5 \text{ g} \leq M \leq 75 \text{ g}$

- Old: 0.1 %
- *New: 0.2 %*

Number of Samples to be tested

T.6: The special requirement for ten prismatic cells to be tested for T.6 (as opposed to five for other cells types) has been deleted. It is obsolete with the below mentioned Crush Test.

T.8: The test is now explicitly also required for component cells. Thus, now T.6 (as already before) and T.8 are the (only) two tests that need to be performed on cells, if these are directly assembled into batteries and not transported separately.

(f): The special relaxed requirement for certain battery assemblies applies only, if they are made up of already successfully tested individual batteries. Relaxed requirements for assemblies made up of already successfully tested cells are not available

No Mass Loss Requirement:

The explicit "no mass loss" requirement for the tests T.1 to T.4 has been deleted. However, since it is now included in the definition of "Leakage" it will be as valid as before in most cases (see also "Definition of Leakage" above).

Test T.2 Thermal test

The upper temperature requirement has been relaxed and the specification of the number of cycles has been clarified.

- Old: upper temperature 75 °C
- *New: upper temperature 72 °C*
- Old: This procedure is to be repeated 10 times
- *New: This procedure is to be repeated until 10 total cycles are complete*

Test T.3: Vibration

For large batteries (≥ 12 kg) the peak acceleration is relaxed to $2 g_n$. For all other samples it remains at $8 g_n$.

- Old (for all samples): $8 g_n$
- *New (for large batteries only): $2 g_n$; (for all other samples): $8 g_n$*

An explicit statement has been added that the requirements (no leakage, no venting, ..., no fire) have to be fulfilled "during the test and after the test", although no indication is given for how long after the test the samples need to be monitored. The voltage requirement (not less than 90 % after the test) is now stated more precisely to apply "directly after testing in its third perpendicular mounting position". This has three implications: the perpendicular z-axis shall be tested last, the voltage only needs to be measured after the third axis (not after the first and second) and the voltage needs to be measured immediately after the test (not e.g. on the next day after a night test).

Tests T.5, T.7 and T.8

Clarification that the requirements (no disassembly, no rupture, no fire) have to be fulfilled also during the test and not just within six hours after the test.

Test T.6: Impact/Crush

A new Crush test was added replacing the Impact Test for most cells. The Impact Test has been clarified.

- Old: Impact test for all samples
- *New: Impact Test only for cylindrical cells with > 20 mm diameter, Crush Test for all other types of cells*
- *New: Crush Test: max. force of 13 kN between flat surfaces.*
- *New: Impact Test: The bar placed across the sample is now specified to be of type 316 stainless steel*

Other changes (not detailed here):

Editorial and Layout. Clarifications without changes of meaning. Definitions of "fire", "nominal energy", "nominal voltage", "open circuit voltage", "rated capacity" and "single cell battery".

Bibliography:

UN ST/SG/AC.10/11/Rev.5:2011: currently effective Rev 5 of the Recommendation on the transport of dangerous goods, Manual of Test and Criteria

UN ST/SG/AC.10/11/Rev.5/Amend.1:2011: Amendment 1 for the above publication



At the time of writing this article the complete Rev 5 of the Manual of Tests and Criteria as well as the Amd 1 were available for free download from the UNECE web page

(http://www.unece.org/trans/danger/publi/manual/manual_e.html).

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