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**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****Fiftieth session**

Geneva, 28 November-6 December 2016

Item 2 (d) of the provisional agenda

**Recommendations made by the Sub-Committee  
on its forty-seventh, forty-eighth  
and forty-ninth sessions and pending issues:  
electric storage systems****Lithium battery T.2 Thermal test****Transmitted by the European Association for Advanced Rechargeable  
Batteries (RECHARGE) and the Rechargeable Battery Association  
(PRBA)<sup>1</sup>****Introduction**

1. At its forty-ninth session, the Sub-Committee agreed to a number of changes to the lithium battery tests in Section 38.3 of the Manual of Tests and Criteria, which were included in document ST/SG/AC.10/C.3/2016/46. One proposed change the Sub-Committee considered but did not adopt would have reduced the maximum temperature requirement in the lithium battery T.2 Thermal test in Section 38.3 of the Manual of Tests and Criteria from  $72 \pm 2$  °C to  $65 \pm 2$  °C. The proposed change was intended to account for cell and battery designs that have non-resettable safety devices typically found in lithium ion cells. This proposed change was presented in informal document INF.56 (forty-ninth session).
2. As explained in informal document INF.56 (forty-ninth session), there are situations in which lithium ion cells or batteries have integrated resettable and/or non-resettable protective mechanisms that are designed to activate due to temperature or mechanical

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<sup>1</sup> In accordance with the programme of work of the Sub-Committee for 2015–2016 approved by the Committee at its seventh session (see ST/SG/AC.10/C.3/92, paragraph 95 and ST/SG/AC.10/42, para. 15).

conditions. When these devices activate, the battery or cell open voltage becomes close to zero volts, thus not meeting the voltage loss pass criteria in the Manual of Tests and Criteria. This means the cell or battery designs technically fail the tests when in fact the tests prove the safety features in the cell or battery are working as designed.

3. An example of such protective mechanism is the non-resettable current interrupting safety device in lithium ion cells, commonly known as CID. How this safety mechanism operates was explained in informal document INF.56 (forty-ninth session).

4. In the late 1980's and early 1990's, the original lithium battery tests in the Manual of Tests and Criteria were initially developed from military specifications because lithium metal batteries were widely used for many military applications. As lithium metal battery technology evolved and became more widely available in consumer applications, the tests were amended accordingly to account for different form factors and chemistries. After lithium ion batteries entered the market in the mid-1990's, the lithium battery tests and Model Regulations were once again amended to account for this new rechargeable technology that did not contain lithium metal.

5. The lithium battery tests in Section 38.3 of the Manual of Tests and Criteria are classification tests and many are intended to simulate what typically will be encountered during transportation. For example, the purpose of the T.1 Altitude test "simulates air transport under low-pressure conditions." The purpose of the T.3 Vibration test "simulates vibration during transport."

6. The T.2 Thermal test "assesses cell and battery seal integrity and internal electrical connections." The test is conducted using rapid and extreme temperature changes ranging from  $72 \pm 2$  °C to  $-40 \pm 2$  °C. Cells and batteries must be stored for at least six hours at these test temperatures.

7. Section 7.1.5.3.1.1 of the Model Regulations states in relation to temperature control requirements: "It is assumed that during transport the temperature of the immediate surroundings of the package does not exceed 55 °C and attains this value for a relatively short time during each period of 24 hours." These assumed maximum transport temperature conditions are reflected in many places throughout the Model Regulations, for example, in prescribing filling conditions for packagings (see, 4.1.1.4 (first sentence) and 4.1.1.10.

The ICAO Technical Instructions states: "For the information of users of these Instructions, the extremes of temperature which may be encountered in international transportation are in the order of  $-40$  °C and 55 °C."

8. These temperature assumptions are supported by numerous formal and informal studies and articles published over the last 10 years that provide data on temperatures recorded in packages and containers during air, sea, and land transport. Some of the studies and articles are available online:

- [https://www.ista.org/forms/2015\\_FAA%20AIR\\_SINGH\\_SAHA\\_SINGH.pdf](https://www.ista.org/forms/2015_FAA%20AIR_SINGH_SAHA_SINGH.pdf)
- <https://interdry.wordpress.com/2012/01/27/ocean-container-temperature-and-humidity-study-2/#comments>
- <http://wscc.scl.gatech.edu/resources/tempinseacontainers.pdf>

9. In addition, during the thirty-fourth session of the Sub-Committee in December 2009, PRBA, RECHARGE and Battery Association of Japan presented nickel metal hydride battery shipping data in informal document INF.11 (thirty-fourth session) that showed the following temperatures:

- For sea transport, the temperatures within containers ON DECK reached a maximum temperature of approximately 47 ° C during the day and UNDER DECK reached a maximum temperature of 34 ° C.
- For air transport, the top surface of packages reached a maximum temperature of approximately 48 ° C.
- For land transport, the cargo hold (pallet top) reached a maximum temperature of 55 °C.

10. As previously noted, the T.2 Thermal test “assesses cell and battery seal integrity and internal electrical connections.” Because studies have shown that lithium cells and batteries will not typically encounter temperatures above 55 ° C in transport, requiring the cells and batteries be subject to 72 °C does not seem warranted. Lowering the temperature requirements in the T.2 Thermal test from  $72 \pm 2$  °C to  $65 \pm 2$  °C as PRBA and RECHARGE proposed at the 49<sup>th</sup> session will provide a large margin of error of 10 °C, cover realistic exposure temperatures in transportation, and no longer disadvantage lithium ion cell manufacturers who design cells to “fail safely” when a CID is activated at temperatures above 65 °C.

## Proposal

11. PRBA and RECHARGE propose the following change to the T.2 Thermal test procedure found in section 38.3.4.2.2 of the Manual of Tests and Criteria:

“Test cells and batteries are to be stored for at least six hours at a test temperature equal to ~~72~~  $65 \pm 2$  °C, followed by storage for at least six hours at a test temperature equal to  $-40 \pm 2$  °C.”

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