



**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****Forty-first session**

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Item 4 (a) of the provisional agenda

Electric storage systems: testing of lithium batteries**T6 tests for lithium cells****Transmitted by the experts from China¹****Introduction**

1. At the thirty-eighth session of the Sub-Committee, the informal lithium battery working group submitted the working paper (ST/SG/AC.10/C.3/2010/81) that proposed the amendments section 38.3 of the Manual of tests and criteria concerning tests for lithium batteries and cells. In the paper, it proposed two tests for T6: impact and crush. Both tests simulate the mechanical abuse that may result in the internal short circuit to cells. The impact test applied to cylindrical cells not less than 20.0mm in diameter, and the crush test applied to the other cells.

2. Chinese experts submitted informal document INF.35 at the thirty-eighth session, which proposed to apply impact tests for all the cylindrical cells. Experts in the meeting thought it was not practicable to apply the impact test to small cylindrical cells. Therefore, we suggested modifying the diameter limit from 20.0 mm to 18.0 mm at the meeting (ST/SG/AC.10/C.3/76, para. 40). At the thirty-ninth session, we submitted informal document INF.36, which proposed to modify the diameter to 18.0 mm. The Sub-Committee suggested to submit an official proposal at the next session (ST/SG/AC.10/C.3/78, para.46).

3. To illustrate the effects of impact and crush tests on cells, we compiled the test data for these two tests respectively, so that we can easily know the difference between crush test and impact test to the cells.

¹ In accordance with the programme of work of the Sub-Committee for 2011-2012 approved by the Committee at its fifth session (refer to ST/SG/AC.10/C.3/76, para. 116 and ST/SG/AC.10/38, para. 16).

4. First, we collected the impact test data on cylindrical cells, which included 261 groups of cells. Among these there were 221 groups of Li-ion cells with a diameter of 18.0 mm (18650), 14 groups of primary cells with a diameter of no less than 18.0 mm {[33.0 mm (33600) - 34.0 mm (341245, 34615)], lithium-SOCl₂} and 26 groups of test data on primary cells with a diameter of less than 18.0 mm {[14.0 mm (14250, 14500, 14335) - 17.0 mm (17335, 17500)], lithium-SOCl₂ and Lithium-MnO₂}. We found only one group of cells with the diameter of not less than 18.0 mm that could not pass the impact test, and the pass rate was more than 99%. For the primary cells with a diameter of less than 18mm, the rate was 65%. All the cells conducted to the test had an obvious temperature rise, for the smaller cells with a diameter of less than 18.0mm (14.0 mm-17.0 mm) which passed the test, the maximum temperature could reach 115 °C. Furthermore some cells caught fire and exploded. And the voltage of all the tested cells dropped to 0V. The data are shown in table 1 below:

Table 1 : Impact test data

| <i>Diameter of cell</i> | <i>14.0mm-17.0mm</i> | <i>18.0mm</i> | <i>33.0mm-34.0mm</i> |
|------------------------------------|----------------------|-----------------|----------------------|
| Number of tested groups | 26 | 221 | 14 |
| Passed groups | 17 | 220 | 14 |
| Pass rate | 65% | 99% | 100% |
| Failure phenomena | Fire, explosion | Fire, explosion | No |
| Voltage drop to | 0V | 0V | 0V |
| Maximum temperature on passed cell | 115 | 105 | 83 |

| <i>Diameter of cell</i> | <i>14.0mm-17.0mm</i> | <i>18.0mm</i> | <i>33.0mm-34.0mm</i> |
|------------------------------------|----------------------|-----------------|----------------------|
| Number of tested groups | 26 | 221 | 14 |
| Passed groups | 17 | 220 | 14 |
| Pass rate | 65% | 99% | 100% |
| Failure phenomena | Fire, explosion | Fire, explosion | No |
| Voltage drop to | 0V | 0V | 0V |
| Maximum temperature on passed cell | 115 | 105 | 83 |

5. Second, we chose 8 groups of cells with a diameter of less than 18.0 mm (14.0 mm and 17.0 mm) for crush test, 4 groups of cells for 14.0 mm and 4 for 17.0 mm. In the 4 groups of cells with a diameter of 14.0 mm, two groups of cells passed the above impact test and other two groups of cells failed. And it is the same for the cells with a diameter of 17.0 mm. All the 8 groups of cells passed the crush test. Also, we run the crush test on 32 groups of cells with a diameter of 18.0 mm including the group of cells which failed in impact test and 8 groups of cells with a diameter of 33.0 mm. Still, all the cells passed the test. Based on the test data, we could see that the crush test cannot make the cells temperature rise obviously, and there are no fire and no explosion. The data are shown in table 2 below:

Table 2 : Crush test data

| <i>Diameter of cell</i> | <i>14.0mm-17.0mm</i> | <i>18.0mm</i> | <i>33.0mm-34.0mm</i> |
|------------------------------------|----------------------|---------------|----------------------|
| Number of tested groups | 8 | 32 | 8 |
| Passed groups | 8 | 32 | 8 |
| Pass rate | 100% | 100% | 100% |
| Failure phenomena | No | No | No |
| Voltage drop | No | No | No |
| Maximum temperature on passed cell | 27 | 31 | 26 |

6. Comparing table 1 and table 2, we note that the effects of impact test are more obvious than crush test for cylindrical cells. In other words, impact test is more effective to appraise the safety of cells during transportation than crush test. For safe transportation, we think the impact test is more reasonable for cylindrical cells, although we can understand that the experts at the thirty eighth session thought it is not practicable to apply the impact test to small cylindrical cells. We still think the cylindrical cells with a diameter of no less than 18.0 mm should conduct the impact test for the following reasons.

7. The shell of cylindrical cells with a diameter of 18.0 mm is rigid. Crush test could not cause the internal short circuit as there is no temperature rise nor voltage drop, and there is only deformation according to the test results. On the contrary, there is 1 group of cells catching fire and exploding in the impact test we conducted. And the temperature of other cells rose to 85 °C to 105 °C, the voltage dropped to 0V. It indicated the cells may have internal short circuit which correspond with the simulation purpose of this test. In addition, this type of cells are used broadly, the “18650” cells used in laptop computer also belong to this type. Keeping them safe is closely related to our life and very important. Therefore, we suggest that this type of cells shall be tested by more effective method: Impact test.

Proposal

8. Based on the discussion above, we suggest to amend the diameter limit in impact test scope, and read as below: (new text underlined, deleted text struck out)

“38.3.4.6.2 Test procedure - Impact (applicable to cylindrical cells ~~greater~~ not less than 20 18.0mm in diameter)

38.3.4.6.3 Test procedure - Crush (applicable to prismatic, pouch, coin/ button cells and the cylindrical cells ~~not more less~~ than 20 18.0mm in diameter)

Note: Diameter here refers to the design parameter (for example the diameter of 18650 cells is 18.0 mm). ”