**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   **4 December 2017**

Fifty-second session
Geneva, 27 November-6 December 2017
Item 4 (b) of the provisional agenda
**Electric storage systems:
testing and lithium batteries**

Report on the informal working group on data gathering for the hazards classification of Li batteries

Transmitted by the expert from France on behalf of the informal working group

Informal Working Group (IWG)

Data gathering for the Hazards classification of Li batteries

Nov 6-8, 2017

Grande Arche La Defense, Paris

Participants:

NAME	ORGANISATION
SCHMIDT Anita	GERMANY (BAM)
OHORI Kenichi	Battery Association of Japan (BAJ)
TAKEDA Koichi	Battery Association of Japan (BAJ)
GIVENS Michael	USA FAA
HILL Richard	USA FAA
WHITE Keith	UK (VCA)
CHANSON Claude	RECHARGE
BERMIS philippe	RECHARGE
PFAUVADEL Claude	FRANCE
VIZY Karoly	FRANCE
GONCALVES Philippe	FRANCE (INERIS)

Group task: investigate the available data about Lithium battery hazards.

FAA, Ineris and RECHARGE provided data, some data from BAJ on button cells. At the current level of 160 datasets it was discussed, that the data may not be sufficient to serve as a source of representative data and more analysis and compilation would be needed.

Also it was agreed to keep access to the data table collected within distribution of the UN IWG.

RECHARGE provided a presentation for summarizing test that could be updated for the working group

Data table comments, parameters to be measured:

- separate HRR (see acronyms list in the annex) for flame and for cell body (in W/m2 or W). HHR is based on max peak values. Add the duration of test and the initial temperature of reaction when available.

- add the gaz flow: l/s.

- The gaz volume has some interest, but it depends on the knowledge about it's explosive properties. When the composition of gaz is not accurately measured (and it is difficult to measure), the gaz volume information may have low specific interest for a classification purpose. Alternatively, a specific assessment for explosivity would be required at least for air transport.

- Other information about gaz emitted: some data are known, but not listed here. A separate table for the gaz composition will be proposed by BAM and INERIS according availability, demonstrating all are toxic, but specifically

focusing on the toxic HF emission. Some concerns have been expressed that the toxicity was higher than that of other plastics, but this would need more demonstration. Also the smoke density was discussed, but several members agreed that a classification of the toxicity was not useful for the moment.

- An analysis of 2 lots of test data from Ineris on large batteries shows that the HRR is same or smaller than the sum of the HRR at the cells level. However, comparability of the test scenarios needs to be further investigated. There is a need to further confirm whether the cells in a battery are not producing more hazards than a comparative number of cells by themselves. More comprehensive data and analysis is required.

- Question of the data reproducibility / number of sample tested.

- Toxicity is depending on the chemistry, but all (or most) are toxic. So the question is raised to define the criteria, how would this be applied?

- **Question of State of Charge (SOC)**: different states of charge compared to 100% may be applicable in the cases the reduced SOC can be controlled and certified (when under control at various stages during the transport operation, which is the case for new batteries from the manufacturer only?). It would correspond to a specific procedure requiring additive testing at the specified lower SOC.

The group has been looking at a test sequence for assessment of the product behavior, in order to understand the type of test and associated data requirements:

List of possible tests based on the previous assumptions:

1. Cell test

    Test 1- heating test to achieve complete combustion reaction (heating or fire, fire is not allowing the gaz amount and composition to be analyzed): Combustion characteristics: Results (R) 1: Energy (heat), power, gaz volume / gaz composition, flame, (smoke and electrical hazards have been classified secondary in the IWG, however it may be important for air transport).

    Test 2- heating until it starts reacting, and test the propagation to adjacent test: Propagation characteristics obtaining the result R2 :propagate/don't propagate/ intermediate cases? (kinetics question, is fast or slow propagation important, criteria on mechanical aspects, maximum temperature and temperature of thermal runaway ignition, flame?)

2. Battery tests

    Test 3 - heating a cell inside the battery until it starts reacting, and test the propagation to adjacent cells: Propagation characteristics obtaining the result R3 :propagate/don't propagate/ intermediate cases? (kinetics question, is fast or slow propagation, mechanical aspects?) Another criteria should be the propagation from one battery to another?

    Test4 - External heating or combustion characteristics?

    Classification (C) criteria: probably two sets of criteria may be considered

    C1- set of criteria for acceptable/non acceptable hazards in normal transport condition, per mode: possibly several levels, per hazard

    C2 -set of criteria for acceptable/non acceptable hazards in fire condition

Classification:

for cells: according Test2 result

1. If R2 don't propagate: results R1 and R2 compared to C1= categories 1 and 2, or more?

2. If R2 propagate: results R1 and R2 compared to C1= more categories.

3. Intermediate cases (according propagation rate, flame no flame, etc..): more categories

4. Other cases to be considered…

For batteries:

- A stepped approach is proposed, probably based first on the classification of the components cells (?)

- Then, if the cell is propagating (or intermediate), another test is necessary to possibly "improve" the classification, the non-propagation being demonstrated at the battery level. Which test?

    • Test3 corresponds to a cell failure, in normal transport conditions.

- If the cell is non-propagating, Test3 would not be necessary.

- Test4 may be useful if a demonstration of less reactive battery (when compared to the sum of cells tested to Test1) can be achieved when exposed to external heat.

    • Test4 may be useful if various thresholds are applicable according the duration of the test, the HRR, or other criteria.

    • Test4 corresponds to the external fire condition.

• **Choice of testing method**: for reproducibility reason, a heater is the better solution for initiating thermal runaway in cells (Test2). Overcharge is recognized as a more severe test for cells (larger amounts of gaz released). For batteries (Test3), other methods may be allowed to initiate thermal runaway, provided they can be demonstrated being as severe. The scenario of overcharge of one cell inside a battery may be further analyzed in relation to Test3.

• The HRR is considered an important parameter in order to quantify the hazard. The rate of propagation could be a test measuring this hazard. The total heat release in a fire/heating test results may not be a differentiating parameter, as all Lithium ion cells measured result in the same range. Based on this, Test2 may provide several of the answers for the hazard assessment, but there is a need to demonstrate the expected correlation between the HRR result in Test1 and the propagation rate in Test2.

• Also the temperature of thermal runaway ignition could be a useful parameter.

Acronyms list

HRR: Heat Release rate
SOC: state of charge
l/s: liters per second
W: Watts

HF: Hydrogen fluoride