

**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

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Item 4 (b) of the provisional agenda

Electric storage systems:

hazard-based system for classification of lithium batteries

**Lunchtime Working Group on Lithium Battery
Classification 26 and 27-June-2018**

1. Two lunchtime working groups (WG) were held to discuss the classification of lithium batteries based on intrinsic hazards. The Chairman suggested the time be spent reviewing the concepts in INF37 as a path forward for the group. Specifically, the steps to be followed should include:

- (a) review of the provisions in INF37 and consider any problems with the approach Identify next steps
- (b) identify a scheme for classification
 - (i) approach will lead to categorization based on hazards (more reactive, less reactive)
 - (ii) flow chart in INF37 poses questions and identifies relevant conditions to be considered for decision
- (c) refine test conditions
- (d) present to Subcommittee for consideration

2. During the previous meeting, the participants generally agreed that categorization of hazards is achievable and attractive. INF37 presented these concepts in a usable form. The approach is a hazard-based approach, not necessarily a risk-based approach as risk will be further considered in the Modal Regulations taking into account probability, risk (assessment) and impact/severity of an event during transport by different modes.

3. The WG agreed that testing on the intrinsic hazards of the cell/battery is an acceptable method. The test conditions are not simulating transport conditions but abuse conditions.

4. The discussion quickly went to specific conditions in reviewing test results. Some delegations questioned whether the concern over gas was confined to pure gas or could include dusts or mists. The group discussed whether the lack of definition on this point had an impact on the result. Some argued the approach should not discriminate between gases or even gas and particulates. If one exists, then it must be addressed in the scheme. The assumption is that all combustible gases produced from a battery thermal event would be considered toxic.

5. The WG reviewed the flow chart presented in paragraph 9 and related tests listed in Annex 1 and 2. Some participants questioned whether the flow chart order was arbitrary or in a necessary sequence. It was noted there is a reason for the sequence based on what conditions lead to a thermal runaway event. The first condition in the flow chart is propagation. An example of a possible propagation test was included in Annex 2. If the cell/battery propagates based on the test conditions in Annex 2, then the answer to the first decision in the flow chart

is yes, and right side of the flow chart is to be used. If the cell/battery did not propagate, then the left side would be used.

6. The propagation test in Annex 2 is a “worst case” situation designed specifically to determine if thermal runaway in a single cell or battery is likely to propagate to neighboring cells. It was clarified this test is not intended to test cells or batteries protected by packaging, but instead to test the design of the cell in a worst-case situation. Additional protections that could be introduced through packaging, battery design or other external materials would be addressed later in the process.

7. Some participants questioned whether the classification process is impacted by cell/battery chemistry. It was noted that while cell/battery chemistry can vary widely, a scheme that addresses every possible cell/battery chemistry in different ways was too complicated and likely unattainable. Further, testing reported during previous sessions indicates cell/battery chemistry may impact propagation. But once a thermal runaway event occurs in the cell, battery chemistry leads to hazards that may be addressed similarly between different cell/battery chemistries.

8. The test method identified in Annex 2 was discussed. The test methodology is based in part by the work being done by the SAE G-27 Group. The G-27 group noted that there are numerous ways to induce thermal runaway in a cell but focused on applying heat to the trigger cell because this is the most reproducible method. Additional methods to initiate thermal runaway are available and should be allowed. However, the equivalence of different methods shall be ensured.

9. The Chairman summarized the principle of the propagation test:

- (a) the intention is to initiate a thermal runaway by applying heat to the cell;
- (b) test is conducted in a chamber to limit environmental variables and capture gas;
- (c) the test must be reproducible;
- (d) State of charge must be 100%;
- (e) the test must be conducted in a way that the heat is applied only to one cell and not the entire battery or set of cells.
- (f) The heat source must be stopped once the test cell enters a thermal event so that the heating source used to initiate thermal runaway doesn't cause other cells to experience a thermal event. The test is to see if thermal runaway propagates from cell-to-cell.

10. The group discussed whether a thermal runaway event test (heating of the cell to see if it goes into thermal runaway) should be conducted prior to a propagation test. However, it was noted that if the cell cannot be heated to the point that it will go into thermal runaway, then it will not propagate, and the flow chart would address a less hazardous cells/batteries on the left side of the chart.

11. The 200 °C temperature for the heat source was chosen because the known melting point of lithium is 180 °C and thus could be expected to reliably produce a thermal runaway.

12. The WG will still need to consider how to address a lithium cell or battery that does not experience a thermal runaway event when heated, for example, to 200 °C over 1 hour or more (limited or no hazard present).

13. After discussing PROPAGATION of the cell or battery, the next step in the flow chart from INF37 is to evaluate whether fire occurs. Participants questioned whether FIRE includes RAPID DISSASSEMBLY. Rapid disassembly could create a projection hazard. It was

suggested that a decision point could be added below FIRE that poses the question of RAPID DISSAEMBLY, yes or no. In general, the WG felt projection or rapid disassembly evaluation would be beneficial but it was not agreed as to where in the process it should be introduced. The WG noted that the flow chart has been simplified to combine hazards when they are related or result from a given decision. For example, it was mentioned that not all gases may be consumed during a fire, but to keep the flow chart simple, it is recognized that if fire is produced, the condition of gas hazard is automatically considered in the final classification. Participants were encouraged to review the flow chart and suggest how it can be improved and share any data on the projection hazard topic.

14. The WG discussed the difficulties of assessing the hazards of a cell that does not propagate but produces heat and gas; is the result dangerous enough to create a risk in transport? Test methodology and evaluation parameters should identify levels of hazard (i.e. high, medium, low, negligible).

15. The WG also discussed the topic of heat release rate and whether that was considered on the non-propagation side of the chart. Several participants commented that heat release rate would be addressed in the temperature increase question when propagation does not occur. For cells/batteries that propagate, the heat release rate must be evaluated so as not show bias regarding the size of the cell (i.e. small cells vs. large cells).

16. The concepts in INF37 address testing of cells. The WG should consider how the hazards of cells relates to a battery. Does a battery manufactured from propagating cells automatically mean a battery will propagate? Is a battery containing non-propagating cells not likely to propagate? What are the consequences to the battery if manufactured from propagating and non-propagating cells. At which point is it possible to stop testing and assign classification by reasoning?

17. After two days of WG, the following action items were identified:

- (a) A definition of propagation must be established;
- (b) The group must consider how the temperature of propagation should be evaluated
- (c) The method for initiation needs to be better defined;
- (d) The issue of projection hazard should be considered and placed either in the flow chart or as a general condition of concern;
- (e) When considering GAS HAZARD, differentiation may be needed to determine toxicity and explosive atmosphere of gas as well as volume.
- (f) The group should determine how to address bias of test methodology regarding the size of the cell. (i.e. is the hazard represented by larger cells or batteries overly emphasized due to size alone).
- (g) How does cell propagation relate to battery propagation?
- (h) At which point is it possible to stop testing and assign classification by reasoning?

18. The WG discussed a time and venue for the next session.

- (a) In conjunction with the December UN Session
 - (i) Hosted by IATA or at another location in Geneva
- (b) In January and hosted by ICAO in Montreal, Canada