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 **7 July 2017**

Fifty-first session
Geneva, 3-7 July 2017
Item 4 (b) of the provisional agenda
Electric storage systems: hazard-based system for classification of lithium batteries

Results of the lunchtime working group on hazard based classification of lithium batteries

The informal working group on hazard classification of lithium batteries met twice during the Sub-Committee sessions. First on 4 July 2017 from 1630 – 1730 and again on 6 July 2017 from 1330 – 1430

Reference documents: ST/SG/AC.10/C.3/2017/16, 51/INF.26

The purpose of the meeting is to define the work on a classification scheme for lithium batteries. This work will continue intersessionally.

The chairman drew attention to ST/SG/AC.10/C.3/2017/16, specifically the hazard table contained in the annex. The Hazard Table (see annex) lists identified hazards, reasons for concern, parameters to be measured, and general notes on the issue.

The chairman invited comments and agreement from the informal working group on the contents of the hazard table.

Thermal: The expert from the Netherlands requested additional discussion on self-sustained burning. This concept is similar to thermal runaway propagation in that the thermal effects of a single cell in thermal runaway spread from cell to cell. Others argued that the existing table already addressed thermal runaway propagation. The table already includes investigating the heat produced by the battery, the heat produced by nearby combustibles and whether burning continues in the presence or absence of oxygen.

The chair reminded the group that the hazards measured here apply to a test article (a single cell or a single battery).

Smoke/Vapor

Production of smoke and vapor were included in the table to acknowledge the potential to produce large quantities of smoke. This can result in decreased visibility of aircraft pilots. There were no specific comments on the smoke/vapor section of the table and this appears to be a concern specific to the air mode. This could be considered a secondary hazard.

Mechanical Hazards – No comment

Chemical – Flammable and Toxic gases

The expert from the Netherlands requested the table separately reflect the hazard associated with the production of toxic gas, flammable gas, and flammable liquid. A clear distinction between the chemical substances contained in the battery that are flammable e.g. electrolyte and the reaction products from thermal runaway e.g. hydrogen gas.

Some cautioned against characterizing the toxicity smoke and other combustion by products as this would be inconsistent with the treatment of other dangerous goods and non-dangerous goods.

Electrical hazards – This refers to the direct hazards associated with the storage of electrical energy in the battery. A high voltage battery or a battery at a high state of charge could result in a more energetic fire than a low voltage battery or a battery at a low state of charge. Electrical arcing could provide an ignition source for flammable gases. The hazard associated with electrical shock are not as relevant for transport as some of the other hazards.

The group decided that three primary hazards (thermal, mechanical, chemical) and two secondary hazards (smoke production and electrical):

Thermal hazards to include fire, and sustained high temperatures

Mechanical hazards – including projections from a ruptured cell or battery and resulting pressure pulse

Chemical hazards to include flammable liquids contained in the cell and combustion by-products including flammable gas and toxic gases.

Smoke – Lithium batteries in thermal runaway tend to produce large quantities of smoke that can impede the ability of aircraft pilots to fly. This could warrant special consideration in the air mode.

Electrical – The enhancing effect of a high voltage battery on a fire. Electrical arcing can provide an ignition source for flammable gases present in thermal runaway.

The chairman introduced 51/INF.26 that proposed an investigative testing plan to answer define:

(a) What tests should be conducted;

(b) What would be a satisfactory representative sampling;

(c) Who would be able to participate in the investigative testing;

(d) Ensuring confidentiality when necessary and appropriate.

The goal of the working group is to develop recommendations for the Sub-committee for the working group to convene at the next session. The approach must be informed by previous testing.

7 July 2017 - Lunchtime WG

The next session of the Lithium battery informal working group will meet in Geneva after the TDG meeting in December. The meeting will take place from Wednesday – Friday; December 6-8, 2017. RECHARGE volunteered to host this meeting. The purpose of this meeting would be to review the test data and develop terms of reference during the December meeting.

A robust discussion has been hindered thus far because of a lack of data. To address this problem the chairman proposed to convene a meeting of a small group <10 people who have data on lithium battery tests will to organize and present existing test data. France would be willing to host this meeting in Paris in September or October. The group would meet in time to provide data to inform the December meeting. Potential participants include RECHARGE, PRBA, DOT, INERIS, OICA.

The informal working group tentatively agreed on the principles provided in 2017/16 and the hazards to be reviewed.

The group discussed the type of test data requested. Test results should relate to the hazards described in annex to 2017/16. Heat effect, fire, gas emission, mechanical projections, on identified products. Smoke, vapor and electrical hazards if available. Test data should include information on the type of product, the size, the shape, the capacity etc., the test procedure used, and the outcome of the tests under the concepts described. Measurements of heat, gas etc. are most beneficial. Identities of the manufacturers etc. should be shielded. INERIS has presented some of this information available in annexes to papers and during the previous session of the informal working group.

The information derived from the test results would identify the predominant hazards and factors the influence the identified hazards, and commonalities amongst tested articles. Based on this the group will identify missing data.

The list of issues are the items that should be reviewed based on the information contained in the test reports. The group discussed the following questions:

(a) What risk/type of reactions have to be assessed?

- (i) fire
- (ii) gas emission
- (iii) toxic fumes
- (iv) projections

(b) How to initiate the reaction in the test?

- (i) exposure to fire (bonfire test)
- (ii) exposure to heat radiation
- (iii) exposure to heat through short circuit
- (iv) overcharge

(c) What is the item to be tested for classification?

- (i) a whole battery (independently from the size);
- (ii) a cell;
- (iii) a “module” or battery part;
- (iv) several of the above mentioned items;
- (v) can the reactivity of the bigger battery be assessed by testing some of the elements.

(d) Other issues

- (i) testing packed or unpacked items (going toward a classification related to the transport packaging);
- (ii) use of the tests to be defined;
- (iii) assessing the violence of the reaction only as a classification factor versus assessing the violence of the reaction and the sensitivity.

Identify a destructive test that can initiate a thermal runaway and measure the effects.

How to initiate? Preferably test information would review the effects of different initiating methods on identical articles.

What object should be tested? Tests on cells, then assembled into a battery, batteries assembled into a module. If the effects of batteries are no different than the cells, then cell data is comparable to batteries. Can it be determined a point in which you can stop testing?

Testing of packaged versus unpackages items. Criteria for highly reactive batteries that require package interventions. Consider testing of explosives. If packing does not impact the effects, then classification decisions need not be based on packaging.

A comparison of lithium batteries could be easier than Explosives because lithium batteries are not sensitive to a pressure pulse. Initiating methods include temperature and puncture. Certain initiation methods such a thermal runaway onset can be informed through cell tests. Propagation test, to measure the ability of thermal runaway to spread from cell to cell in a battery and a package is also useful. Reproducibility of tests methods is important. If you can define the results heat, effects etc. then you can test a package without the contents. If the hazards of a battery cannot be reduced intrinsically, then packaging could be used. Once this information is determined, packaging could be considered.

The group then considered other issues

Threshold values of hazards: The hazard table considers the hazards associated with lithium batteries equally without considering if a certain amount of heat or gas emission is acceptable. The group could set threshold values for acceptable reactions, then anything below the threshold value is acceptable. Threshold values must be based on validated tests. If the test is used to determine the threshold, the test would be used to verify the design. Decisions on test criteria, method of initiation and test procedure should be informed by testing result.

Flow chart concept for classification. A negative reaction/result will lead to another logic box to arrive at a classification. This concept could be worth exploring but the types and severity of lithium batteries are much more variable than substances. Batteries have design considerations e.g. designed vent ports and thus the hazards of a battery may be greater or less than the hazards exhibited by the cells. An overall principle is that the test procedure shall be design type neutral. A generic testing procedure applicable to all battery designs.

The end goal is to provide a testing procedure to verify design, and allow changes in a design to achieve a safer result. Test methods must be easily usable by cell and battery designers to assess the safety of a changed battery design. Testing should incentivize the development and use of safer battery designs. Caution that design changes should improve safety not just pass the test. Review the variability of testing results.

Violence of a reaction. Consider not only the hazards posed by a lithium battery in thermal runaway but the sensitivity of the cells. For example, two cells that produce identical reaction products (heat, gas etc., but one cell requires more energy to initiate the reaction. Sensitivity of the battery is an important factor to consider. The small WG can consider this. The group will collect data on the sensitivity of different batteries.

Useful data would be Allow to check the effects.

Compare reaction of one call, versus multiple cells

Outside package versus inside the package

Same effect temperature but higher need more to initiate the reaction.
