UN Informal Meeting on Lithium Batteries – 2019-2020

1 September 2020 – Video Conference

**Introduction**

1. George Kerchner (PRBA) and Claude Chanson (RECHARGE) welcomed participants to the session. The intent of the meeting is to update the group on the testing that has been completed over the past 10 months. Given the current restrictions on travel due to the COVID-19 pandemic, the group was not able to meet in person.
2. Agenda for call:
   1. General status of Informal Working Group and Test Group
   2. Lab test plan
   3. Phase 1 results summary
   4. Phase 2 preliminary results
3. It was noted that significant amounts of data had been submitted within the last 5 days.
4. Concept proposals and test data presented at the meeting are available from the RECHARGE Website
5. In addition, all historical documents related to the current Informal Working Group are also posted on the RECHARGE Website.

**General status of Informal Working Group and Test Group**

1. Significant testing by 8 labs since October 2019
   1. Cells tested at different states of charge
   2. Partial results were presented at this session.
2. Next scheduled session planned for December 2020 following the UN Sub-Committee Meeting in Geneva, Switzerland.

**Lab Test Plan**

1. Phase 1 was all about test of repeatability. 7 labes tested propagation in a row of 6 cells, 3 repetitions with cells at 100%.
2. Phase 2 was to test effect of heating rate and SOC on propagation for 6 cells in a row.
   1. 4 labs have submitted results on these tests.
3. Included test of effect of heating rate and SOC on propagation on gas hazards
   1. single cell test (test series 4 and 6).
   2. 2 labs have submitted results on these tests.

**Phase 1 Results Summary**

1. Propagation times were reviewed.
   1. Some labs experienced long propagation times (up to 190 seconds for cells), while other labs experienced much shorter times (20-60 seconds) for cylindrical cells.
   2. Pouch cells propagation times were much shorter but were similar across all labs.
2. Max temperatures
   1. Max cell temperatures were consistent across most tests (800-1000 oC) with a few outliers that exceeded 1200 oC. These values were the same for both cylindrical and pouch cells.

**Phase 2 Preliminary results**

1. Effect of initiation method on max temperature
   1. Data indicated temperatures were not significantly different across all cell types and laboratories. This suggests that the method of initiation does not result in differences in the max temperature of the thermal event.
2. Effect of heating rate on thermal runaway propagation and max temperature.
   1. Results were quite scattered showing no clear trend. This can be compared to other states of charge through additional tests.
   2. The group discussed the importance of reviewing different heating methods and determining how they impact propagation. But this will need to be reviewed in future tests.
3. Stability of the max temperature during self propagation at various SOC
   1. Max temperature of cells (pouch and cylindrical) remained at or near 800 oC for SOC between 100% to 50%. However, at 20% SOC, propagation did not occur. Cell 1 was heated to 200-350 oC but adjacent cells did not heat to propagation.
   2. However, there were differences when comparing results from 3 different laboratories at 50% SOC. In at least one test, the cell did not propagate. This suggest there is something in the test methods that is resulting in a different result.
4. Effect of SOC and type of cell on Thermal run-away propagation
   1. Data suggests propagation rate is more sensitive to shape than max temperature. Cylindrical cells take longer to propagate, but neither will propagate if there is not enough energy in the system.
5. Review of gas during tests
   1. Test was conducted on single cell with gas collected in combustion chamber.
   2. Data presented for gas provided less clear results. Additional analysis will need to be conducted.
   3. Heating rate appears to impact max temperature reached.
   4. Percentage of gas (CO2 and CO) produced was similar.
   5. HF and HCl production were different for pouch and cylindrical cell. However, this may be due to different manufacturers between the pouch and cylindrical cells. It was also noted that HF is highly reactive and very difficult to measure.
   6. Gas testing may not be available at all labs. Therefore, data reported may be reduced. There is already significant literature references on gases produced from lithium ion cells. Therefore, it may be better to start with existing research and compare test results to what is expected.
   7. Effort on gas production could ultimately encourage safer cell designs by demonstrating what is the worst case for gas production.

**Possible Conclusions**

1. Lithium batteries hazard characterization
   1. Tests demonstrate some level of reproducibility of the thermal runaway hazards, but still needs analysis for characterization of it, particularly for gas production.
   2. Some key parameters influencing the hazards per cell, and their propagation, are tested (cell format, cell SOC) but may need to be completed.
2. Test Method
   1. The heater method provides a reproducibility way to initiate a thermal runaway. Limit of conditions still need to be detailed (heating rates, heater types, …)
   2. The TR obtained by the heater is close to the one obtained by self propagation, although the propagation time is very different, demonstrating some robustness to the method.
3. Reproducibility between labs
   1. Larger differences between labs than within a single lab
      1. Test description will have to be more specific and precise
      2. Identified effect of
         1. Absence of lid on test chamber
         2. Various efforts for compression during test
         3. Possibly heating rate range
         4. Others to be discussed…
4. The group discussed other topics that were not specially measured.
   1. The peak temperature and duration of reaction. Concerns over peak temperature and the ability to melt aluminum is of concern to the air mode. Experience has suggested that while peak temperature can exceed 600 oC and aluminum that is part of the cell/battery may melt, this is due to the concentration of heat in the cell and would not represent the same conditions if released or ejected from the cell or package. Additional testing would be necessary to confirm this opinion.

**Next Steps**

1. Complete the tests table and analysis (anonymized labs names)
2. Circulate to all labs for review
3. Further elaborate on the pending issues to prepare the December Meeting
   1. Hazard characterization
   2. Method description
   3. Labs comparison
4. Review how testing supports larger effort on classification of lithium batteries in transport.
5. The group was reminded that the mandate of the WG is to characterize the hazards and define tests for lithium batteries, not develop transport conditions. Thus, the future efforts need to remain focused on hazard characterization on lithium ion AND metal cells and batteries and determine whether those hazards can be subdivided into relative risks.
6. BAM noted they are conducting research on existing battery data available in literature on different battery types and would present the information at the next session. It was noted that the testing being conducted by the group was to collect data that is currently not available. A comparison between what has been published and our testing results would be beneficial.

**Schedule of next meetings**

1. The following timeline is suggested for future actions:
   1. 9-10 December 2020 – IATA Center – Geneva, Switzerland