

## Summary of the 29<sup>th</sup> Plenary Special Committee 235 - Non-Rechargeable Lithium Batteries

### Meeting Summary:

The 29<sup>th</sup> Plenary Meeting of Special Committee 235 (SC-235) was held on June 29, 2023. The meeting was conducted as a Virtual Meeting with the following attendees participating via WebEx.

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| John Trela (Chairman)                                 | The Boeing Company                       |
| Norman Pereira (Government Authorized Representative) | Federal Aviation Administration          |
| Jeff Densmore (Secretary)                             | Radiant Power Corporation                |
| Karan Hofmann (Program Director)                      | RTCA, Inc.                               |
| Antonio Chiesa  | Transport Canada                         |
| Nick Conquest   | National Institute for Aviation Research |
| Maria Jose  | Airbus                                   |
| Nazih Khaouly   | Federal Aviation Administration          |
| Thomas Maloney  | Federal Aviation Administration          |
| Frederic Menard                                       | Orolia                                   |
| Kathryn Mulhollen                                     | U.S. Air Force                           |
| John Neilson  | Ultralife                                |
| Paul Pfeifer  | Textron                                  |
| Ray Rodriguez   | U.S. Air Force                           |
| Jim Russell   | The Boeing Company (retired)             |
| Adrian Sfetcu   | Bell Helicopter Textron, Inc             |
| Mel St John   | National Institute for Aviation Research |

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### Opening Plenary

- The 29<sup>th</sup> Plenary meeting of SC-235 was convened on June 29, 2023 at 10:00am EDT by Chair John Trela (Boeing). Jeff Densmore (Radiant Power) was the SC-235 Recording Secretary.
- Norman Pereira was introduced as the Government Authorized Representative.
- An RTCA overview, including RTCA's Proprietary References Policy was read by Karan Hofmann, the Program Director.
- Welcoming remarks were made by John Trela. Each person in attendance was invited to introduce themselves.

- The meeting agenda was reviewed.
- The Meeting Summary for SC-235 Plenary #28 was reviewed and approved with minor edits to the recorded Thermal Runaway discussion. These edits have been incorporated and the updated meeting summary has been posted on AerOpus.
- All documents and presentation material reviewed during Plenary #29 have been uploaded and are available in the RTCA AerOpus documents folder for this meeting.

### **Plenary #28 Action Item Review**

There was one new Action Item assigned during Plenary #28, with status as follows:

Propose revisions to the applicable Battery Short Circuit with Protections Disabled requirements and procedures to address Fuses and Fusible Links.

**Assigned to:** Norm Pereira and Antonio Chiesa

**Status:** CLOSED. A proposed revision to the Battery Short Circuit with Protections Disabled requirements and procedure was presented during this Plenary meeting. See below for details.

### **DO-227B Comment Resolution**

At the conclusion of the previous Plenary meeting (#28) held in May, the committee agreed that a second round of a Final Review and Comment (FRAC) period was warranted given the large number of changes to the document during the on-going FRAC resolution period. Additionally, there remains some unresolved issues with the Battery Short Circuit with Protections Disabled requirements and test procedures that still require consensus. At the close of Plenary 28, it was agreed that the working group would focus on two primary tasks: conduct final editorial cleanup of the document and seek consensus on the above issues.

Prior to Plenary 29, three versions of the draft DO-227B were created and posted on AerOpus for committee member review prior to the meeting. These versions were: (1) a “clean” version of the current document (e.g. no change tracking), (2) the current draft showing changes from the FRAC version and (3) the current draft showing changes from DO-227A.

The objective of Plenary 29 was to reach consensus on the Battery Short Circuit with Protections Disabled requirements and procedure and to approve the document for a second FRAC.

### **Battery Short Circuit with Protections Disabled Discussion**

Two (2) competing views of these requirements and test procedures exist within the committee. One is to allow for NOT disabling of fuses and fusible links (as currently allowed for in DO-227A) and the other is to disable ALL protective devices including fuses and fusible links. The committee spent most of the Plenary discussing this topic.

During Plenary 28, engineering test results were shared with the committee showing that without fuse protections, thermal runaway can be initiated by shorting some battery chemistries in different cell configurations. Configurations most at risk were ones containing serial strings of cells, though TR was also observed under other conditions.

As noted above, Antonio and Norm were assigned an action to propose revisions to the Battery Short Circuit with Protections Disabled requirements and test procedures. These proposed changes were presented and discussed, with a copy uploaded onto AerOpus. The proposal can be summarized as the removal of the “Fuses and Fusible Links” exception of protections required to be disabled. It was also proposed that a failure of the “Leak, Vent, Rupture, or Fire” safety requirement could be mitigated at the end item level, but not allowed for a battery that is an end-item.

The proposal was discussed at length with several comments and questions raised including:

- In the updated procedure, it is suggested to *Prepare a test sample battery by disabling all protective devices, except for any device that cannot be bypassed without rendering the battery non-functional*. Questions asked were:
  - How should these devices be disabled? As an example, if a fuse is present on a Printed Wiring Board, should it be removed from the board and replaced by a jumper (or a jumper placed in parallel)? If so, should the jumper wire be of the same current carrying capability as the fuse or should it be more robust? If it is the same “rating” it would demonstrate the protective features of the fuse. If it is a greater rating, does the applicant have to evaluate the next weak point in the design and bypass those as well? The feedback was that this should be left to the applicant to determine.
  - If the protective devices are internal to the battery, disassembly will be required to disable them. In some cases, this may be destructive or may not be possible. For example, the fuse may be inaccessible due to potting within the battery. Are there conditions that would not require fuses to be disabled other than *without rendering the battery non-functional*? The feedback was that the applicant should consult with their civil aviation authorities if there are limitations.
  - The statement *rendering the battery non-functional* was considered vague. The concern was that applicants could claim that a fuse was integral to the design and bypassing it creates a test article that is not functioning as designed.
- A comment was made that the 5mΩ short circuit requirement is difficult to achieve. This was a general comment and not specific to the proposed changes. It was made to share actual testing experience and the difficulties in achieving this short circuit impedance, especially when the battery interface design utilizes small connectors.
- Because this test could result in a thermal runaway, it was suggested that appropriate NOTES and CAUTIONS be placed in the document in this section to warn of potential safety risks of performing this test.
- Footnote 7 was added to the proposed Battery Test Evaluation Criteria (Table 2-4) stating *This is a failure at the battery level. If used at the End Item level, this failure may be mitigated at the end item level. The condition is reportable. If the battery is offered independently, no mitigation is possible and leak and/or vent is considered a failure. The battery used in the demonstration of mitigation at the End Item level must comply with item a of the Test Setup above*. The last statement implies that end-item mitigation requires repeating the short circuit test at the end item level. It

was questioned why successful completion of the existing Thermal Runaway Test would not satisfy this mitigation? In response, it was stated that perhaps a TR resulting from an unprotected Battery from an external Short Circuit behave differently than one initiated by heating. To counter, it was stated that during the development of DO-227A the committee previously concluded that the worst-case TR occurred when initiated by overheating a cell. This discussion ended without a conclusion.

Discussions continued throughout the Plenary without progress towards consensus. Differing opinions continue to be unresolved and can be summarized as follows:

***Not in favor of disabling Fuses and Fusible links:***

- (1) The current DO-227A document allows for NOT disabling fuses and fusible links.
- (2) It can be expected that disabling fuses and fusible links will result in a Thermal Runaway for some Test Articles
- (3) Disabling fuses alter the physical design whereby the test article is not representative of the intended design.
- (4) It is not clear how or when a fuse should be disabled.
- (5) If disabling is required, other design techniques could be employed to yield an equivalent protection without the use of fuses. For example, the use of undersized traces within a Printed Circuit Board or the use of very light gauge wire in harness interconnects that would fail as an open circuit under high current. In these examples, the function of the fuse is preserved, but the manufacturability of the product becomes more complicated.
- (6) Disabling Fuses would be a significant change from DO-227A. The concern is that DO-227A compliant equipment would not be approved for future installations if these requirements were changed.

***In favor of disabling Fuses and Fusible links:***

- (1) Fuses have been known to fail. Therefore, testing should take this into account and demonstrate the test article's ability to meet safety requirements (e.g., cannot leak, vent, rupture, or emit fire).
- (2) Allowances can be made to mitigate failures of these types at the end-item level.

The lengthy discussion left little time to address comments provided by several committee members on the posted draft DO-227B document, including a concern regarding the changes to the list of gases to be collected after the TR testing. Continued lack of consensus prevented the committee from approving the document for release to the second FRAC process. It was agreed to continue to discuss during working group meetings with the goal of presenting a resolution at the next Plenary meeting.

**Action Item Summary**

There were no new actions generated during Plenary #29:

**Working Group Meetings**

It was agreed that Working Group meetings should be held on Wednesdays from 10:00am to 11:30am (EDT) leading up to the next Plenary.

### **Next Plenary**

The committee decided to wait to schedule the next Plenary meeting. This would allow time for the Working Group to continue to seek consensus and also review other committee members' comments on the Draft DO-227B.

-S-  
Jeff Densmore  
Secretary

***CERTIFIED*** as a true and accurate summary of the meeting.

-S-  
John Trela  
Chairman