

Summary of the 33rd Plenary Special Committee 235 - Non-Rechargeable Lithium Batteries

Meeting Summary:

The 33rd Plenary Meeting of Special Committee 235 (SC-235) was held on March 5-7, 2024. The meeting was conducted at the RTCA Facility in Washington, DC with in-person and virtual attendees participating via WebEx.

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
Jim Dellinger	National Institute for Aviation Research
Tom Jaeger **	American Airlines
Maria Jose **	Airbus
Nazih Khaouly **	Federal Aviation Administration
Frederic Menard	Safran Electronics and Defense Beacons
Paul Pfeifer	Textron
Fernando Menedez Rodriguez **	EASA
Jim Russell **	The Boeing Company (retired)
Adrian Sfetcu **	Bell Helicopter
Greg Smith	U.S. Air Force
Clayton Vondrasek **	Garmin Ltd

** Attended Virtually

Opening Plenary

- The 33rd Plenary meeting of SC-235 was convened on March 5, 2024 at 9:00am 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 #32 was reviewed and approved as written. The meeting summary has been posted on AerOpus.
- All documents and presentation material reviewed during Plenary #33 have been uploaded and are available in the RTCA AerOpus documents folder for this meeting.

Plenary #32 Action Item Review

There were no open Action Items following Plenary #32

DO-227B Final Review and Comment

During Plenary #31, the committee approved a change to the Terms of Reference (ToR) which updated the FRAC Completion Date from March 2023 to June 2024 as shown.

DELIVERABLES:			
Product	Description	FRAC Completion Due Date*	Change
DO-227B	Minimum Operational Performance Standard for Non-Rechargeable Lithium Batteries	June March 2024	March 2022 2023

*Note: Final Review and Comment (FRAC) completion Due Date refers to the date that the committee plenary approves the document after completing the FRAC Process. SCs should submit the final document at least 45 days before the PMC meeting where it will be considered approval.

The ToR Update was presented and approved during the PMC December 2023 meeting.

DO-227B Final Review and Comment

Plenary #33 was the first plenary of SC-235 following the second Final Review and Comment (FRAC) process for DO-227B. The second FRAC comment period closed on January 12, 2024 with the following summary of comments received.

Comment Type	Quantity	Percentage
Non-Concur	15	4.3%
High	35	10.1%
Medium	104	29.9%
Low	81	23.3%
Editorial	113	32.4%
	348	

Comments were received from the following organizations:

- EASA
- FAA
- Transport Canada
- The Boeing Company
- Radiant Power Corp
- SAFRAN Electronics and Defense Beacons SAS
- Airbus
- Textron
- NIAR

Following the close of the second FRAC comment period, several Working Group meetings were conducted to discuss the comments and resolve those possible (mostly editorial). During those discussions, a few additional comments were entered into the register and some comments were reclassified with concurrence of RTCA and the committee leadership.

Of most significance, all of the comments from NIAR were reclassified from “Non-Concur” to “Medium”. The original comment classifications were in error due to a misunderstanding of the category definitions. NIAR provided written concurrence of the reclassification of their comments.

Entering Plenary #33, the status of all comments were as follows:

Comment Type	Total	Resolved	Percentage	Unresolved	Percentage
Non-Concur	1	0	0%	1	100%
High	35	3	8.6%	32	91.4%
Medium	119	19	16%	100	84%
Low	95	9	9.5%	86	90.5%
Editorial	100	64	64%	36	36%
	350	95	27.1%	225	72.9%

The primary purpose of Plenary #32 was to discuss and resolve the last remaining comments and proceed to a second Final Review And Comment (FRAC) process. The follow two items were discussed:

1. Battery external short circuit with protections disabled.
2. Thermal Runaway Chamber Sizing Discussion

Several Working Group meetings were held to review these items prior to Plenary #32.

Comment Discussion and Resolution

Non-Concurs

As mentioned above, there were fourteen *Non-Concur* comments from NIAR. After reviewing them during the Working Group meetings, all of these were reclassified to *Medium* due to a misunderstanding of the category definitions.

This left only one (1) *Non-Concur* comment from Radiant Power which reads as follows:

During the Dec 2023 PMC Meeting, Hette Hoekema from EASA stated that once DO-227B is adopted, EASA will require all future NRLB installations to be compliant with the latest standard (DO-227B). This is a significant cause for concern as MANY conversations have occurred during the drafting of DO-227B regarding the acceptability of products qualified to DO-227A. Per FAA (Pereira) and TCCA (Chiesa), products previously qualified to DO-227A will continue to be deemed acceptable for new installation as long as an incident or other issue does not arise / occur that would deem DO-227A unacceptable. If EASA's position is as stated above, Radiant Power is concerned that previously qualified products will have to be re-qualified to the new standard to be approved for installation. This is a significant impact to equipment manufacturers and installers. If this is EASA's position regarding DO-227A, then Radiant will issue a "Non-concur" to the release of DO-227B.

Discussing this comment during the Plenary meeting, Jeff Densmore from Radiant Power acquiesced that the Non-Concur is not directly applicable to DO-227B, but rather more directed towards the adoption of DO-227B such as an Advisory Circular, Special Condition Guidance, etc. However, given EASA's comments during the December PMC, it appears that EASA has already decided that future installation approvals will no longer accept DO-227A compliant equipment. This would require currently compliant equipment to be requalified to DO-227B which is an impactful (9-12 month) proposition. Underwater Locating Devices (ULDs) and Portable Emergency Locator Transmitter (ELTs) would be particularly impacted as they are often subject to new installations.

Fernando Menedez Rodriguez from EASA stated that he was not aware of a "pre-determined" position regarding the adoption of DO-227B and that this would not occur until after the document was released. Additionally, it was stated that a "RevA" to "RevB" comparison table would assist in the regulators' assessment of the changes and applicability of the current DO-227A to installation requirements.

Jeff Desmore from Radiant Power concluded the discussion by stating that the Non-Concur will be withdrawn and appreciated everyone's attention to this impactful issue.

High, Medium, and Low Comments

The following table summarizes the comments reviewed and resolved during the Plenary meeting.

Id	Category	Section	Subject	Comment	Disposition	Resolution
68185	Non-Concur	General	DO-227A Acceptability for Future Installations.	During the Dec 2023 PMC Meeting, Hette HOEKEMA from EASA stated that once DO-227B is adopted, EASA will require all future NRLB installations to be compliant with the latest standard (DO-227B). This is a significant cause for concern as MANY conversations have occurred during the drafting of DO-227B regarding the acceptability of products qualified to DO-227A. Per FAA (Pereira) and TCCA (Chiesa), products previously qualified to DO-227A will continue to be deemed acceptable for new installation as long as an incident or other issue does not arise / occur that would deem DO-227A unacceptable. If EASA's position is as stated above, Radiant Power is concerned that previously qualified products will have to be re-qualified to the new standard to be approved for installation. This is a significant impact to equipment manufacturers and installers. If this is EASA's position regarding DO-227A, then Radiant will issue a "Non-concur" to the release of DO-227B.	Withdrawn	Comment does not address the MOPS content. The question of applicability is at a higher level.
68060	High	2.4.2	Missing information	Missing information regarding passivation of battery pack (as established for cell in paragraph 2.4.1)	Accepted	Copied the txt from the 2.4.1 cell section here to allow de-passivation of the cells in batteries.
68061	High	2.4.2.1.2	Not clear	Temperature monitoring not required	Accepted	Removed temperature measurements from batteries because any internal flaw that would cause heating would also be detected by the OCV measurements.
68062	High	2.4.2.2.2	Missing information	"Instrument the battery for surface temperature measurements." -> number of probes and location not defined	Accepted	Added test setup to provide means of measuring cell warming.
68063	High	2.4.2.2.3	Missing information	"Instrument the two batteries for temperature measurement. -> number of probes and location not defined	Accepted	Added definition of ways to measure temperature
68064	High	2.4.2.2.3	Remove information	"Maximum cell and battery temperatures reached during the post-impact test period." -> highly difficult to perform for cells embedded in battery pack	Accepted	Removed cell temperature from the reportables because it is difficult to instrument.
68068	High	2.4.1.2.1	Harmonization	difference between method and Reportable Items : "once per second or faster" "a. Sample rate shall be at least 1 / minute."	Accepted	The common term is aligned as "at least 1 / minute."
68069	High	2.4.2.2.5	Harmonization	refers to the battery discharge when it is the cell that is discharged	Accepted	Cells may have a large increase in impedance at very low SOC, leading to very long discharge times to reach the target. Consider ways to reword the criteria that include capacity, impedance changes, and current capability.
68128	High	2.4.1.1.2	Test setup	Line 1024 and 1041 require an APSD analysis for the response of the cell. There is no requirement to instrument the cell for vibration (only the control input). If we require analysis of the response it will require instrumenting accelerometers on all 45 cells which is more than the available inputs on most vibration table setups. Our lab has 8 inputs currently and upgradeable to 16. Additionally the data would be of little or no value. Any change in the APSD response would mean an internal cell failure which would be observed with the OCV measurement currently required on each cell.	Accepted	Clarified there are two accelerometers to measure the input driving spectrum as well as the fixture response.

Id	Category	Section	Subject	Comment	Disposition	Resolution
68129	High	2.4.1.1.3	Test setup	Shock test should only require instrumenting the control. No reason to instrument all 45 cells for shock (DO-160G does not require instrumenting the test article). Doing so will be above the inputs available for many shock/vibe tables requiring multiple test runs. Additionally the data would be of little or no value.	Accepted	Shock measurements will be at the table and the fixture locations.
68134	High	2.4.1.2.6	Reportable requirement	Reportable item b. requires data from a thermal runaway. I believe (not explicitly clear) that a thermal runaway would be considered a failure in which case data documentation is not needed.	Accepted	Removed reportable b, as after a Tr there is no need for additional condition data.
68140	High	2.4.2.1.2	Test setup	Line 1408 and 1021 require an APSD analysis for the response of the battery. There is no requirement to instrument the battery for vibration (only the control input). If we require analysis of the response it will require instrumenting accelerometers on all 36 batteries which is more than the available inputs on most vibration table setups. Our lab has 8 inputs currently and upgradeable to 16. Additionally the data would be of little or no value. Any change in the APSD response would mean an internal battery failure which would be observed with the OCV measurement currently required on each battery.	Partially Accepted	Clarified that the APSD is for the fixture response, not the test article.
68362	High	2.1.4 c	Need to be clear	End Items shall use batteries that meet this MOPS. (DO-227A or later revision. 270 Batteries may be qualified as End Items.).	Partially Accepted	Deleted items b and c. Updated the provisos in the battery (2.2.2) and end item (2.2.3) introductory sections.
68364	High	2.4.1.1.2	clarification	This test is to be performed on a set of 45 sample cells. This is a generic comment that applies to cells within the batteries and end item.	Clarified	Provision to use undischarged cells is mention at the start of the section 2.4.1.
68375	High	2.1.2	Airworthiness in MOPS	As an ETSO approval is normally different installations and as the installation architecture is not known at the time of the ETSO authorization, it is impossible to provide all the necessary information. Therefore this requirement is not verifiable and as such not valid. Airworthiness title and references inside the text are not adequate. Title should be more adequate when referencing Installation, Maintenance and Operation.	Partially Accepted	Airworthiness is part of the RTCA template and should be preserved. The required aspects were changed to guidance.
68378	High	2.1.3	clarify responsibilities	The current formulation allows that either the cell or the battery manufacturer is defining the intended functions.	Accepted	Rewrote the requirement to apply to all components.
68391	High	2.1.15	requirement unverifiable	it is still an unverifiable requirement at end item level.	Partially accepted	The requirement for warning was changed to guidance.
68394	High	2.2	means of compliance	Normally section 2.4 should only include a possible means but not the only means to show compliance to the requirements of sections 2.1 and 2.2. This change from will to shall makes all of section 2.4 something that has to be reassessed. Linked with paragraph 1.6.	Rejected	Not required for clarification of 1.6 and 2.2
68398	High	2.2.1.2.1	removal to be justified	Please provide the ELOS (equivalent level of safety) or a justification for the removal of the following: "Another fundamental aspect is the ability to partially discharge at maximum current capability without residual negative effects. "	Accepted	Returned the sentence to the rationale.
68070	Medium	2.4.2.2.5	Harmonization	"Step g." does not exist.	Superseded	
68071	Medium	2.4.2.2.6	Harmonization	reference to "Figure 2-19." not relevant	Superseded	
68131	Medium	2.2.1	Test order	Requirement to follow the specific test order in figure 2-26 seems unneeded and puts additional burden on the tester. Allowing alternate order will provide greater ability to schedule available lab resources.	Rejected	The order of testing may have an effect due to compounding effects

Id	Category	Section	Subject	Comment	Disposition	Resolution
68215	Medium	2.4.2.2.2	Battery Drop Test	Battery OCV measurement was not required in 227A. The P/F criteria table for batteries had a “blank” in this category. Discussing during WG and FRAC concluded that it should be NA (“-”). Reference Plenary #13. Why has it be added?	Accepted	Comments from Plenary 33: DO-227 did not contain cell and battery drop tests. When the Battery Drop Test was added in DO-227A, Table 2-4 “Battery Test Evaluation Criteria” had a blank entry for OCV and OCV was not measured in the test procedure. Table 2-4 was modified to show a “-“ in the OCV column (meaning N/A) in the first FRAC DO-227B version and did not receive any comments during FRAC 1. However, while in Plenary 27 in March 2023 the “-“ was changed to “F1” and test procedure steps to measure OCV prior to and following the drop were added. This happened during a discussion of the Pass / Fail criteria for the Drop Test with respect to Distortion. The rationale for making the OCV change was not documented in the FRAC 1 spreadsheet or Plenary 27 Meeting Minutes. During Plenary 33, the status of this OCV pass / fail criteria was discussed and the majority of the committee felt that the OCV measurement was not needed since this is an abusive test that needs to meet the other requirements of Table 2-5: Leakage, Venting, Distortion, Fire, and Rupture.
68251	Medium	2.4.1.1.2	precision	Cells mounted in spring-type holders may not experience the vibration correctly.	Accepted	Added text to specify rigid cell-holding.
68255	Medium	2.4.1.2.1	Correct data	There is no specification in the standard as to where in the discharge circuit the voltage measurement leads should be connected. The connection location can make quite a difference and should be stated.	Accepted	Accepted and added a comment to survey other tests for consistent wording on voltage connection points.
68271	Medium	2.4.2.2.4	Procedural	There is no setup step for adding the voltage measurement wiring.	Superseded	
68272	Medium	2.4.2.2.4	Procedural	There is no preliminary step to measure the loop resistance.	Accepted	Added a set up step to measure the end-to-end loop resistance
68346	Medium	2.4.2.2.4	Battery External Short Circuit	Test Setup missing current, voltage and video cameras instrumentation/equipment.	Partially Accepted	Added setup for imagery, voltage / current.
68347	Medium	2.4.2.2.4	Battery External Short Circuit	Suggest changing test procedure item a as proposed on the right column.	Superseded	
68349	Medium	2.4.2.2.5	Battery Single Cell Short Circuit with ...	Test Procedure item e calls for video recording while Reportable Item e calls for still images.	Accepted	Resolved as "e. Still images from the video of the battery.."
68376	Medium	2.1.3	clarify responsibilities	The current formulation allows that either the cell or the battery is not providing the intended functions, which is not what is stipulated in the rational.	Accepted	Rewrote the requirement to apply to all components.
68377	Medium	2.1.3	shall in rationale	The rational shall not contain requirements, therefore the use of the word "must" was correct. "Must" states, that somewhere else this is formulated as a requirements.	Accepted	Removed "shall"
68388	Medium	2.1.9	Calibration	"When appropriate" is not an adequate way to propose a requirement. Calibration shall be a topic covered by means beyond this MOPS.	Accepted	Removed from 2.1.9 and augmented 2.3.2 to address calibration sources.
68392	Medium	2.1.16	identification of test to be repeated to be explicitly mentioned	Add that the change impact analysis shall also identify all the tests that have to repeated after the design change has been implemented.	Accepted	Add that the change impact analysis shall also identify all the tests that have to repeated after the design change has been implemented.
68127	Low	2.4.1.1.2	Incorrect reference	Section 2.4.1.1.2 is Cell Vibration testing, but the cross reference in line 1015 points to DO-160G 7.3.1 which is Crash Safety.	Accepted	Suggest pointing to DO-160G section 8.3
68130	Low	2.4.1.1.3	reference	The referenced section 7.3.1 in DO-160G is for Crash Safety.	Superseded	

Id	Category	Section	Subject	Comment	Disposition	Resolution
68132	Low	2.4.1.2.1	sample rate	Sample rate in step a. does not align with the data requirements in the Reportable Items starting on line 1215.	Superseded	
68139	Low	2.4.1.1.2	test setup	Section 2.4.2.1.2 for the battery vibrate test details using a fast response voltage sensor in the setup section. This is absent from the Cell vibrate test setup (ref line 1399 for battery setup).	Rejected	Cells do not have the same vibration damage effects as battery, so there is no need for fast OCV during cell vibration testing.
68146	Low	2.4.2.2.2	test setup	Adding instrumentation to the battery for temperature measure will likely have a negative impact on the test especially when trying to test specific orientations	Superseded	
68152	Low	2.4.1.1.2	test procedure	Procedure allows running two bands of 10 to 500 Hz and 500 to 2000 Hz. DO-160 Section 8 allows two bands, but uses 10 to 600 and 600 to 2000. Is the difference intentional or simply a typo? Question also applies to lines 1397 and 1940	Accepted	Removed the specific frequency bands and instead refer the reader to the DO-160 standard.
68182	Low	2.4.1.1.2	Redundant step	Measuring post test OCV is already in Step a (line 1010)	Accepted in previous comment	
68183	Low	2.4.2.2.5	incomplete setup statement	Step a. has you instrument the battery, but the data requirement is for cell temps.	Partially accepted	Suggest clarifying test setup step a. to specify that battery cells are to be instrumented.
68198	Low	2.4.1.2.1	Cell Discharge Test	Sample Rate clarification.	Superseded	
68203	Low	2.4.1.2.6	Cell Pressure Control (Venting) Test	requiring a linear control of the chamber temperature (procedure step b) drives testing to a traditional environmental chamber. As such obtaining video evidence of this test has become more difficult as environmental chambers offer much smaller viewing windows with multiple layers of glass which provides poor viewing of the test article.	Accepted	Change to read: Increase the temperature at a rate not exceeding 10°C every 30 minutes until evidence of venting is observed visually, or the samples burn or rupture.
68207	Low	2.4.2.1.2	Battery Vibration Test	Reportable item f states: All other measured data that was recorded during the test. This is vague and should be removed. If specific reportables are required, they should be explicitly listed	Superseded	
68214	Low	2.4.2.2.2	Battery Drop Test	Test setup step a discusses the instrumentation of the battery test articles for temperature. Adding thermocouples to the batteries prior to dropping may (and do) affect the orientation of the batteries as they are dropped. Suggest ability to apply thermocouples to batteries after they are dropped	Superseded	
68273	Low	2.4.2.2.4	consistency	Some sections just say compliance to Table criteria but this says including reportable conditions	Acknowledged	be consistent

During Plenary #33, the committee successfully reviewed and resolved 47 comments. The resulting status of all comments is shown below.

Comment Type	Total	Resolved	Percentage	Unresolved	Percentage
Non-Concur	1	1	100.0%	0	0.0%
High	35	21	60.0%	14	40.0%
Medium	119	34	28.6%	85	71.4%
Low	95	22	23.2%	73	76.8%
Editorial	100	64	64.0%	36	36.0%
	350	142	40.6%	208	59.4%

Requirements Rationale

During the working group meetings, Antonio Chiesa from Transport Canada identified inconsistencies with the requirements rationale throughout the document. As a result, he submitted a proposal of suggested changes to improve the document.

An action was assigned during the Plenary to add each of these comments to the master spreadsheet and review during the Working Group meetings.

DO-227B Final Review and Comment (FRAC) Schedule Update

John Trela reviewed the schedule progress towards closure of the FRAC process as summarized below:

- Second FRAC Start: 14 Nov 23
- FRAC Comments Due: 12 Jan 24
- Plenary #33 (WDC): 3-7 Mar 24
- Plenary #34 (WDC) – planned: 14-16 May 24
- FRAC Closure – planned: 26 Jun 24
- DO-227B Transmitted to RTCA: Early July 2024
- RTCA PMC Approval: Sep 2024

Action Item Summary

There were no new actions generated during Plenary #32:

- 1) Consult with Cell and Battery OEM's regarding transient OCV variation (timing and characteristics) as a result of the vibration environment. These inputs will help shape the monitoring requirements.
 - a. Assigned to: Jim Russell
 - b. Status: OPEN
- 2) Delegate resolution of the requirements rationale changes proposed by Antonio Chiesa
 - a. Assigned to: Jim Russell
 - b. Status: OPEN
- 3) Create a DO-227A vs DO-227B comparison Table for Insertion into the document
 - a. Assigned to; Jeff Densmore and John Trela
 - b. Status: OPEN

Working Group Meetings

Working Group meetings will continue on Mondays and Wednesdays from 10:00am to 11:30am (Eastern).

Next Plenary

Plenary #34 was scheduled for 14-16 May 2024 at RTCA's facility in Washington, DC.

-S-
Jeff Densmore
Secretary

CERTIFIED as a true and accurate summary of the meeting.

-S-
John Trela
Chairman