

Deviation Request ETSO-C142a#5 for an ETSO approval for CS-ETSO applicable to NON-RECHARGEABLE LITHIUM CELLS and BATTERIES (ETSO-C142a)

Consultation Paper

1 Introductory Note

The hereby presented deviation requests shall be subject to public consultation, in accordance with EASA Management Board Decision No 7-2004 as amended by EASA Management Board [Decision No 12-2007](#) products certification procedure dated 11th September 2007, Article 3 (2.) of which states:

“2. Deviations from the applicable airworthiness codes, environmental protection certification specifications and/or acceptable means of compliance with Part 21, as well as important special conditions and equivalent safety findings, shall be submitted to the panel of experts and be subject to a public consultation of at least 3 weeks, except if they have been previously agreed and published in the Official Publication of the Agency. The final decision shall be published in the Official Publication of the Agency.”

2 ETSO-C142a#5 NON-RECHARGEABLE LITHIUM CELLS and BATTERIES

2.1 Summary of Deviation

Deviates from RTCA DO-227 by permitting, for articles of LiFeS₂ chemistry, a 5% change in Open Circuit Voltage during the temperature tests, if it remains less than 5% for the complete sequence and if it is shown to meet the 2% limit within 45 days.

2.2 Original Requirement

RTCA DO-227

2.1.3 Cells

(...)

Table 2-1: Cell Evaluation Criteria

(...)

1. The change in open circuit voltage during the test shall be less than 2%.

(...)

2.1.4 Batteries

(...)

Table 2-2: Battery Evaluation Criteria

(...)

1. The change in open circuit voltage during the test shall be less than 2%.

2.3 Industry

The LiFeS_2 cells and batteries have a particular chemistry, which exhibits a slow dynamic behaviour when temperature or load conditions are changed. Under load, this is characterised by a rapid decrease in voltage from around 1.8V for a fresh cell to around 1.5V under load (e.g. 100mA). When the load is removed, the measured terminal voltage rises slowly to the final Open Circuit Voltage (OCV). Note that this effect is also observed in Lithium Ion rechargeable cells and much research is directed both at the estimating the OCV and establish the non-linear relationship between OCV and state of charge. A similar effect is seen when storage temperature is changed.

This effect causes a problem with determining the value of a cell OCV both pre-test and post-test. The measurement of OCV is intended to be a simple test, in addition to the absence of leak, vent, distortion, fire or rupture, to indicate an issue during the environmental test sequence. As the measured terminal voltage is a dynamic, time-dependant parameter, it is not possible to verify a steady state OCV.

The change of OCV during the temperature-cycling tests (-55°C to $+85^\circ\text{C}$) for cells and batteries subject to this deviation exceeds the 2% criteria set by DO-227 tables 2-1 and 2-2, but remains less than 5%.

DO-227 requires that the OCV change does not exceed 2% between the value before and after each of the following tests that must be run in sequence¹:

- Vibration,
- Shock,
- Temperature Cycling,
- Altitude,
- Decompression,
- Humidity.

Conversely, DO-227 does not require that the change of OCV for the complete sequence (from before the vibration test to after the drop test) is limited. In other words, it is permitted that the OCV varies of 2% at each test, which means a change of OCV of $6 \times 2\% = 12\%$ is acceptable.

Furthermore, DO-227 assumes that the OCV does not vary over time after each test, and an OCV variation after one or several tests could result in an even larger OCV variation between the start and the end of the sequence.

In the case of the cells and batteries subject to this deviation, it is proposed that:

1. The change of OCV between the start and the end of the sequence is further limited to 5%;
2. The OCV is shown to return within the 2% limit set by the DO-227 after a sufficient time, by performing the following additional test on a separate batch of 5 representative cells:
 - a. Measurement of the OCV;
 - b. Cell temperature cycling test;
 - c. Measurement of the OCV on the cells put at rest during a period of 45 days.

¹Additional tests are required but the change of OCV is not an acceptance criterion for those.

2.4 Equivalent Level of Safety

The deviation provides for an equivalent level of safety to the relaxed OCV criteria (5% instead of 2%) for the temperature-cycling test because

- the change of OCV on the complete test sequence is required to be maintained within the same 5% limit, showing the absence of degradation, whereas the DO-227 is only limiting the OCV to 2% for each individual test; and
- the OCV is demonstrated to return within 2% of the initial value after the temperature-cycling over a period of time compatible of the time dynamic of the cell chemistry.

2.5 EASA position

We accept the deviation.