European Aviation Safety Agency

European Technical Standard Order (ETSO)

Subject: **NON-RECHARGEABLE LITHIUM CELLS and BATTERIES**

1 - Applicability

This ETSO gives the requirements which Non-Rechargeable Lithium Cells and Batteries that are manufactured on or after the effective date of this ETSO must meet in order to be identified with the applicable ETSO marking.

Note: Lithium sulphur dioxide (LiSO2) batteries approved under ETSO-C97 "*Lithium Sulphur Dioxide Batteries*" dated 24/10/2003 may still be manufactured under the provisions of their original approval, but new applications for non-rechargeable lithium sulphur dioxide batteries must meet the MPS of this new ETSO. If there are major design changes to lithium cells and batteries approved under current version of ETSO-C97, they must comply with this ETSO-C142a.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None

3 - Technical Conditions

3.1 – Basic

3.1.1 - Minimum Performance Standard

RTCA DO-227 "*Minimum Operational Performance Standard for Lithium Batteries*" from June 1995 unless otherwise specified by **Appendix 1** of this ETSO

3.1.2 - Environmental Standard

Non-Rechargeable Lithium Cells and Batteries must be tested according to RTCA DO-227 Section 2.3 unless otherwise specified by **Appendix 1** of this ETSO

3.2 - Specific

None

4 - Marking

4.1. - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2. – Specific

Each lithium cell or battery must be marked in accordance with RTCA DO-227, Section 1.4.6.

5 - Availability of Referenced Document

See CS-ETSO Subpart A paragraph 3

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APPENDIX 1.

MINIMUM PERFORMANCE STANDARD FOR LITHIUM BATTERIES

PURPOSE.

This appendix prescribes the MPS for lithium batteries as modified by this ETSO.

REQUIREMENTS.

The standards applicable to this ETSO are set forth in the industry standard, RTCA/DO-227 "Minimum Operational Performance Standard for Lithium Batteries" dated June 23, 1995.

The standard is modified as follows:

Table 1. Modifications to RTCA/DO-227

RTCA/DO-227 section and title:	***Required modification:***
1.5.11, Design Life	**TO ADD at the end of the paragraph** "Equipment manufacturers are responsible for ensuring that the integrity of date coding systems used by the cell/battery supplier(s) will support design life criteria."
1.7.3, Lot Acceptance Test Goals	**TO ADD at the end of the paragraph** "It is recommended that the manufacture's lot acceptance testing include the discharge tests described by paragraph 2.4.1.1 Capacity-Verification Test."
2.1.2 b, Performance Requirements	**TO ADD at the end of the paragraph** "If the battery is required to operate in temperatures outside this envelope, test the battery using the more severe temperatures."
Table 2-1, Cell evaluation criteria	**TO DELETE the superscript "4" on the** Internal Short-Circuit Test row under the "FIRE" column. The superscript "4" is only used under the Forced-Discharge, External Short-Circuit, and Charging tests, and then only under the "LEAK" and "VENT" columns.
2.1.8.2, Test Tolerances	**TO ADD new paragraphs after 2.1.8.2** **Rated Capacity and Current** Except as otherwise specified in the test methods in subsections 2.3 and 2.4, the rated capacity and current must be the same for all testing in this standard.
Warning - Hazards of Testing	When subjected to electrical testing specified in this document, cells or batteries may leak or vent hazardous materials, burn, or in exceptional cases, vent violently.
2.3.1, Vibration Test	**TO REPLACE** Figure 2-3 with the modified Figure 2-3 STANDARD RANDOM VIBRATION Figure 2-3 in appendix 1 of this ETSO. This revised figure depicts different limit lines.

2.3.1, Vibration Test	**TO REPLACE** Figure 2-4 with the modified Figure 2-4 STANDARD RANDOM VIBRATION Figure 2-4 in appendix 1 of this ETSO.. This revised figure depicts different limit lines.
2.3.1, Vibration Test	**TO ADD** before the last sentence in the eighth paragraph "Measure the open circuit voltage (OCV) before, during, and after the tests."
2.3.2, Shock Test	**TO REPLACE** the wording with "For the battery shock test, mount samples in the equipment in which they will be used. Perform this test using undischarged sample cells or batteries. Secure the sample to a shock table by a mechanically secured device. The shock test machine must be capable of imparting a series of calibrated shock impulses to the sample. The shock impulse waveform distortion at any point on the waveform may not be greater than 15 percent of the peak value of the shock pulse. The duration of the shock pulse is specified with reference to the zero points of the wave. The shock forces are specified in terms of peak amplitude g values. Measure the shock impulse using a calibrated accelerometer and associated instrumentation having a 3db response over a range of at least 5 to 250 Hz. Mount the sample on the shock test machine so that the shock impulses can be applied in both directions of the three orthogonal axes. For general purposes, use the following test parameters. Apply a 75 g saw tooth wave shock impulse with a duration of 11 +2 ms in both directions of the three orthogonal axes. Measure the open circuit voltage before and after the test. Examine each sample to determine if it meets the requirements of Table 2-1 and 2-2. For applications with shock requirements in excess of the general test (that is, where crashworthiness, ELTs, or survivability is an issue), use the following more stringent requirements. Apply a 100 g half sine wave shock impulse with a duration of 23 +2 ms in both directions of the three orthogonal axes. Measure the open circuit voltage (OCV) before, during and after the test. Examine each sample to determine if it meets the requirements of Table 2-1 or Table 2-2."
2.3.3, Temperature Cycling Test	**TO CHANGE** 10 times to 9 times
2.3.3, Temperature Cycling Test	**TO ADD** to the end of the paragraph, "…for either method."
2.4.1.2, Discharge Test	**TO ADD** after the second sentence in the first paragraph, "Set the DC power supply to a voltage limit equal to the number of cells per series string in the battery times the OCV of an individual cell."
2.4.1.2, Discharge Test	**TO ADD** to the end of the first paragraph

"If the sample contains one or more protective devices, set the test current to just below (by no more than 10 percent) the current at which any protective device will activate during the forced discharge test."

2.4.1.3, Forced Discharge Test

TO DELETE the fourth sentence: If the sample contains one or more protective devices, the test current is just below (by no more than 10%) that at which any protective device will activate during the forced discharge test.

2.4.1.3, Forced Discharge Test

TO ADD to the end of the paragraph
"This test is not required for single cell batteries. Test the cells up to and (possibly) including the maximum rate of discharge specified by the manufacturer. Rate any protective device at or below the discharge rate specified by the manufacturer. Perform all testing according to this rating."

2.4.2.1, Internal Short-circuit Test

TO REPLACE the first paragraph with
"This test is designed to determine the effects of an internal short circuit in undischarged cells. At 24^{o} C, deform the sample between a rod with a hard insulating surface and an insulated plate. Each cell is deformed until the open circuit voltage drops abruptly or is reduced to at least one third. At the point where the cell voltage drops, remove the applied force. Allow the sample to cool to 24 °C and then hold for a minimum of 24 hours. Examine each sample to determine if it meets the requirements of Table 2-1"

3.4, Test Procedures for Installed Equipment Performance

TO ADD new paragraph after 3.4.

Toxic Gas Venting Precautions

Do not install or use batteries that can vent toxic gases in the aircraft cockpit, because of an increased probability of immediate flight crew impairment. Batteries that can vent toxic gases may be installed or used in an aircraft passenger compartment, if the installer shows that this would not create a safety hazard. You can prevent a safety hazard by:

a. Installing a system for overboard venting, absorption, or containment, or
b. Showing that, if venting occurs, permissible exposure limits do not exceed those maintained by safety-standard organizations (Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists, Inc.).

3.4, Test Procedures for Installed Equipment Performance

TO ADD new paragraph after 3.4

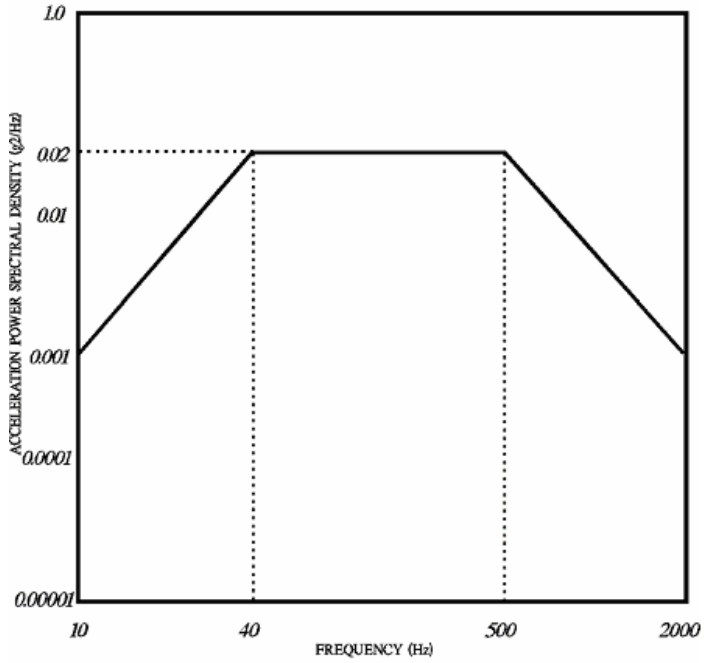
(a) Because lithium batteries have ignited, vented gas or exploded, we require additional performance standards governing the use of lithium batteries or

equipment incorporating lithium cells or batteries on airplanes.

Airplane and equipment manufacturers incorporating lithium cells or batteries must ensure that if there is a fire within a single cell of the battery, the equipment unit will contain the fragments and debris (but not smoke/gases/vapors) from a battery explosion and fire. Fire within the equipment, such as from wires and electrical components, must self-extinguish.

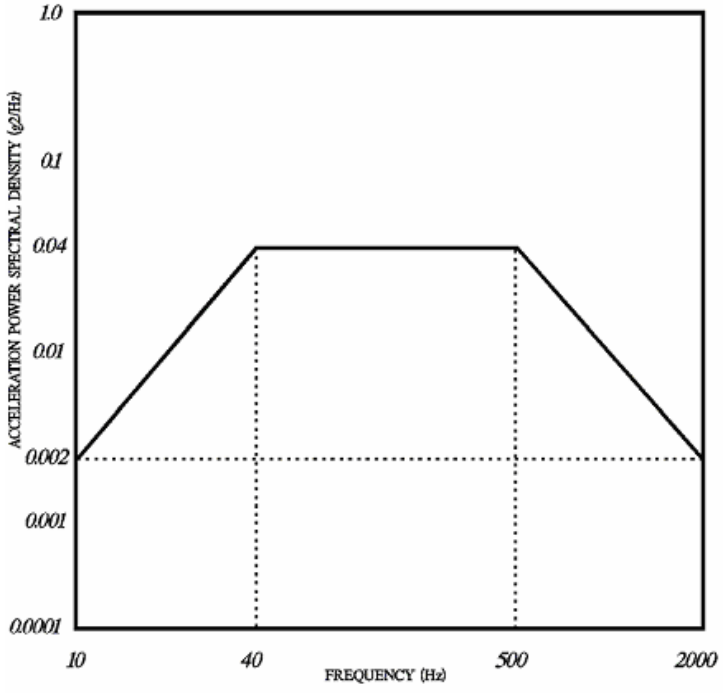
(b) See Table 2, appendix 1 of this ETSO. for tests to ensure that the manufacturer has met the fire safety requirements for equipment incorporating lithium cells or batteries.

Figure 2-3. Standard Random Vibration Test Curves for Equipment Installed in Fixed Wing Aircraft with Turbojet Engines



NOTE: All slopes are ±6 dB/Octave and the cumulative spectral power density is 4.12 g (rms).

Figure 2-4. Robust Random Vibration Test Curves for Equipment Installed in Fixed Wing Aircraft with Turbojet Engines



NOTE: All slopes are +6 dB/Octave and the cumulative spectral power density is 6.08 g (rms).

Table 2. TESTS FOR FIRE SAFETY REQUIREMENTS

Test	Procedures	Criteria to Pass
External Short Circuit	Measure direct connection between terminals through electric wire with resistance of 2m-ohm. State of Charge (SoC) of a cell : 100%	No venting of gases/vapors. No smoke produced. No ignition or fire. No explosion.
Crush	Test battery by dropping an iron ball (9.1 kg) from the height of 61cm SoC of a cell : 50%	No venting of gases/vapors. No smoke produced. No ignition or fire. No explosion.
Over discharge	Test battery by discharging with a current of 1C for 1 hour (or to the maximum discharge time for the battery operation). SoC of a cell : 0%	No venting of gases/vapors. No smoke produced. No ignition or fire. No explosion.
Overheat	Test battery by heating up to 115 degrees C in the oven. SoC of a cell : 100%	No venting of gases/vapors. No smoke produced. No ignition or fire. No explosion.
Fire	Test equipment unit with battery in place for fire penetration by igniting a single unit. SoC of a cell : 100%	Unit must contain the fragments/debris from explosion but not gases/vapors/smoke. Fire within the unit must self-extinguish. Note that the presence of a fire extinguishing or suppression system outside the battery (such as in the equipment compartment) may be used to provide this feature if the system is designed to handle this fire threat.