Number：CTSO-C142a
Date of approval：June 12, 2015
Approved by：Yang Zhenmei

China Civil Aviation Technical Standard Order

This China Civil Aviation Technical Standard Order (CTSO) is issued according to Part 37 of the China Civil Aviation Regulations (CCAR-37). Each CTSO is a criterion which the concerned aeronautical materials, parts or appliances used on civil aircraft must comply with when it is presented for airworthiness certification.

Non-Rechargeable Lithium Cells and Batteries

1. Purpose.

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for a non-rechargeable lithium cells and batteries CTSO authorization (CTSOA). This CTSO prescribes the minimum performance standards(MPS) that non-rechargeable lithium cells and batteries must first meet for approval and identification with the applicable CTSO marking.

2. Applicability.

This CTSO affects new application submitted after its effective date. Major design changes to article approved under this CTSO will require a new authorization in accordance with section 21.310 of CCAR-21R3.

3. Requirements.

New models of non-rechargeable lithium cells and batteries identified and manufactured on or after the effective date of this CTSO

must meet the MPS qualification and documentation requirements in RTCA Inc. document, RTCA/DO-227, Minimum Operational Performance Standards (MOPS) for Lithium Batteries, dated June 23, 1995, sections 2.0, as amended by appendix 1 of this CTSO. RTCA/DO-227 contains requirements and guidance on chemical composition, quantity of potentially hazardous substances, cell size, cell construction, interconnection of cells into batteries, fusing, venting, current limiting and testing. RTCA/DO-227 also covers operational and storage environments, packaging, handling and battery disposal that affect the use of these articles in aircraft.

a. Functionality. This CTSO's standards apply to non-rechargeable lithium cells and batteries intended to provide power for aircraft equipment including emergency and standby systems. Non-rechargeable cells and batteries are also called primary.

b. Failure Condition Classifications. Failure of the function defined in paragraphs 3 and 3.a of this CTSO is a major failure condition. Develop cells and batteries to, at least, the design assurance level equal to this failure condition classification.

c. Functional Qualification. Demonstrate the required performance under the test conditions in RTCA/DO-227, Sections 2.2 and 2.4, as amended by appendix 1 of this CTSO.

d. Environmental Qualification. Test the equipment according to

RTCA/DO-227, Section 2.3, as amended by appendix 1 of this CTSO.

e. Deviations. For using alternative or equivalent means of compliance to the criteria in this CTSO, the applicant must show that the equipment maintains an equivalent level of safety. Apply for a deviation under the provision of 21.310(b) in CCAR-21R3.

4. Marking.

Mark each cell or battery permanently and legibly with all the information in 21.312(d) of CCAR-21R3 and RTCA/DO-227, Section 1.4.6.

5. Application Data Requirements.

The applicant must furnish the responsible certification personnel with the related data to support design and production approval. The application data include a statement of conformance as specified in section 21.310(c)(3) in CCAR-21R3 and one copy each of the following technical data:

a. Operating instructions and equipment limitations, sufficient to describe the cell or battery's operational capability. Describe any deviations in detail. If needed, identify cell or battery by part number, version, revision, and criticality level of software/hardware, classification for use, and environmental categories.

b. Installation procedures and limitations, sufficient to ensure that the cells and batteries, when installed according to the installation

procedures, still meet this CTSO's requirements. The limitations must identify any unique aspects of the installation. Finally, the limitations must include a note with the following statement:

"This article meets the minimum performance and quality control standards required by a CTSO. Installation of this article requires separate approval."

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. List of components, by part number, that make up the cells or batteries complying with the standards in this CTSO. Include vendor part number cross-references, when applicable.

f. A component maintenance manual (CMM), covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed cells or batteries. Instructions should include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph 5.a of this CTSO.

g. Material and process specifications list.

h. The quality control system description required by section 21.143 and 21.310(c)(2) of CCAR-21R3, including functional test specifications. The quality control system should ensure that it will detect any change to the approved design that could adversely affect compliance with this CTSO MPS, and reject the article accordingly.

i. Manufacturer’s CTSO qualification test report.

j. Nameplate drawing with the information required by paragraph 4 of this CTSO.

k. A list of all drawings and processes (including revision level), to define the article’s design.

l. An environmental qualifications form for the cells or batteries describing the environmental tests conducted.

6. Manufacturer Data Requirements.

Besides the data given directly to the authorities, have the following technical data available for review by the authorities:

a. Functional qualification specifications for qualifying each production article to ensure compliance with this CTSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures within 12 months after CTSO authorization.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. The results of the environmental qualification tests conducted per RTCA/DO-227, Section 2.3, as modified by appendix 1 of this TSO.

7. Furnished Data Requirements.

If furnishing one or more articles manufactured under this CTSO to

one entity (such as an operator or repair station), send one copy of the data in paragraphs 5.a through 5.f plus 5.i for each article manufactured under this CTSO.

8. Availability of Referenced Documents.

Order RTCA documents from:

Radio Technical Commission for Aeronautics, Inc.

1150 18th Street NW, Suite 910, Washington D.C. 20036.

You may also order them online from www.rtca.org.

Appendix 1. Minimum Performance Standard for Lithium Batteries

1. Purpose. This appendix prescribes the MPS for lithium batteries as modified by the authorities for reference in this CTSO.

2. Requirements. The standards applicable to this CTSO 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

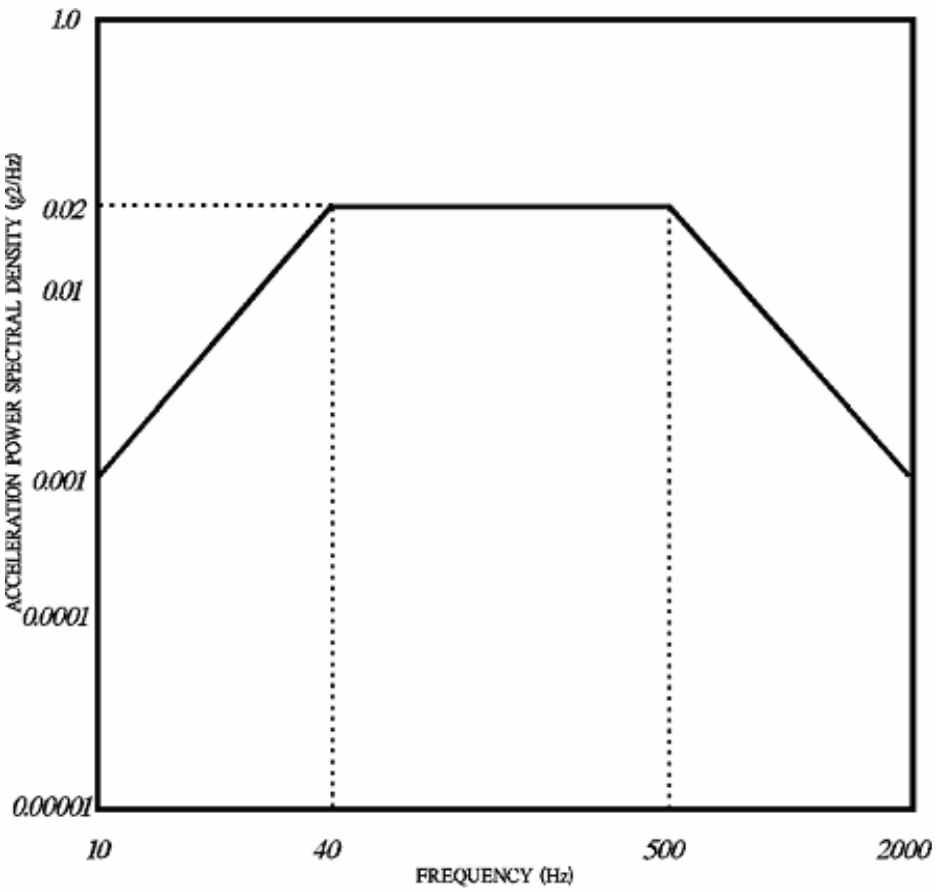
RTCA/DO-227section and title:	Modification:
1.5.11 Design Life	**ADD at the end of the paragraph** “Equipment manufacturers are responsible for ensuring that the integrity of date coding systems used by the cell/battery supplier(s) will support design life criteria.”
1.7.3, Lot Acceptance Test Goals	**ADD at the end of the paragraph** “We recommend 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	**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	**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	**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 Figure 2-3	**REPLACE** Figure 2-3 with the modified STANDARD RANDOM VIBRATION Figure 2-3 in appendix 1 of this CTSO. This revised figure depicts different limit lines.
2.3.1, Vibration Test Figure 2-4	**REPLACE** Figure 2-4 with the modified STANDARD RANDOM VIBRATION Figure 2-4 in appendix 1 of this CTSO. This revised figure depicts different limit lines.
2.3.1, Vibration Test	**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	**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	**CHANGE** 10 times to 9 times
2.3.3, Temperature Cycling Test	**ADD** to the end of the paragraph, "…for either method."
2.4.1.2, Discharge Test	**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	**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	**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	**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	**REPLACE** the first paragraph with "This test is designed to determine the effects of an internal short circuit in undischarged cells. At 24℃, 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℃, 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	**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

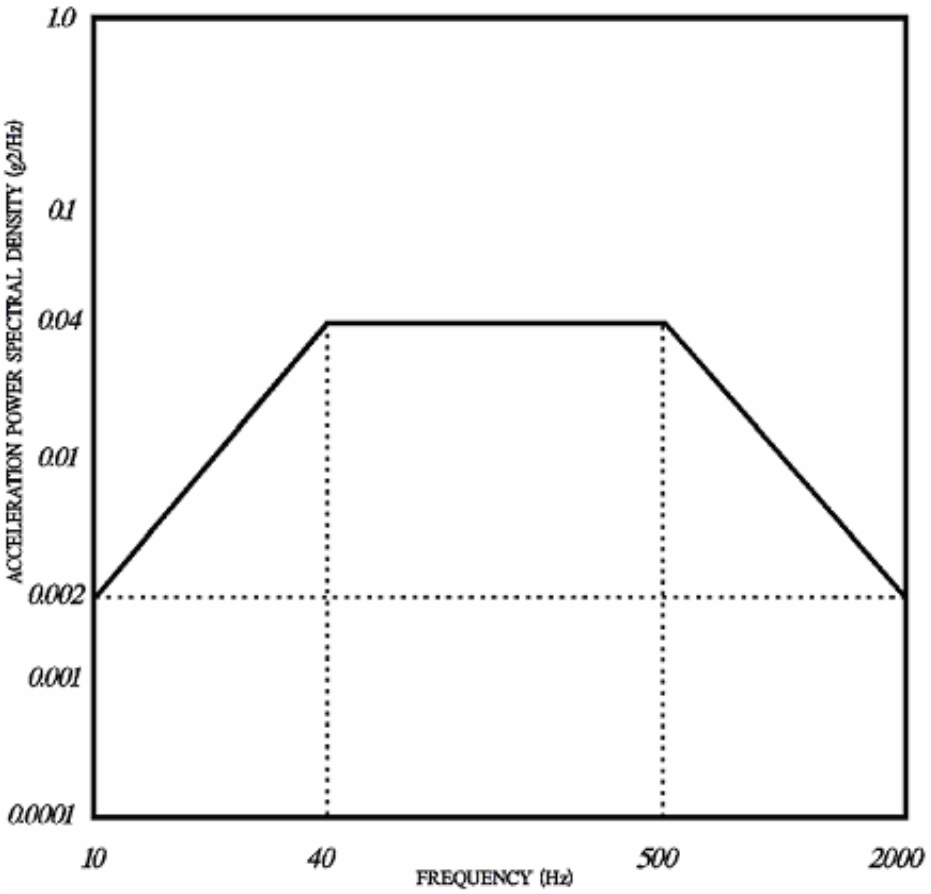
	containment, or b. Showing that, if venting occurs, permissible exposure limits do not exceed those maintained by safety-standard organizations (Occupational Safety and Health Administration and the American Conference of Governmental Industrial Hygienists, Inc.).
3.4, Test Procedures for Installed Equipment Performance	**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 CTSO 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.