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Minimum Operational Performance Standards for Non-Rechargeable Lithium Batteries

RTCA DO-227B
December 12, 2024

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FOREWORD

This document was prepared by RTCA Special Committee 235 (SC-235), and was approved by the RTCA Program Management Committee on December 12, 2024.

RTCA Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization develops consensus-based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

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- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and
- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunications Union and other appropriate international organizations can be based.

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EXECUTIVE SUMMARY

This document was prepared by RTCA Special Committee 235 and approved by the PMC on December 12, 2024. DO-227B was created to address issues and questions which arose from applicants who were following the DO-227A standard and to address deviation requests to the document. Refinements to testing requirements and procedures have been incorporated in DO-227B that resulted from DO-227A testing experience.

Special Committee 235 membership includes representatives from cell and battery manufacturers, equipment manufacturers, aircraft manufacturers, regulatory and other government agencies, and related industry associations.

The Committee reviewed and considered existing regulatory requirements and multiple standards and resources associated with non-rechargeable lithium batteries in developing this revised standard. These standards and resources include the AAIB Aircraft Accident Report 2/2015, Special Conditions related to non-rechargeable lithium batteries, DO-227, DO-227A, DO-160G, UL 1642, UN section 38.3, IEC 60952, IEC 60086-4, and ISO-7137 [see Appendix F References].

This standard provides updated design, testing, and installation guidance for non-rechargeable lithium batteries battery systems, and end items which are permanently installed on aircraft or used in aviation.

The intent of this standard is to assist equipment designers and manufacturers in the selection of non-rechargeable cells and battery systems whose safety and performance have been demonstrated as appropriate to the aviation environment. Section 1 (Purpose and Scope) discusses the scope of this standard, and provides guidance, best practices, and a list of some basic terms of reference.

Section 2 (Equipment Performance Requirements and Test Procedures) contains requirements and associated procedures for non-rechargeable lithium cells, batteries, and end items powered by lithium batteries including general, performance, safety, and functional requirements and tests.

Section 3 (Aircraft Installation Considerations) provides information that may impact the design or aircraft installation of the battery system or end item. It also provides cautions and advice for the installer. This section is intended to provide installation guidance and considerations that may help applicants to meet the airworthiness regulation requirements for the installation of non-rechargeable lithium batteries on aircraft.

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1 PURPOSE AND SCOPE

1.1 Purpose

The purpose of this standard is to establish a Minimum Operational Performance Standard (MOPS) for non-rechargeable lithium cells and batteries installed as or in end items on aircraft. This standard contains a set of requirements, tests, and evaluation criteria to establish and assure the safe operation of end items which are powered by non-rechargeable lithium batteries containing lithium metal or lithium alloys. This standard applies to batteries used as the main power source or that are used for back-up or stand-by power. Guidance is also provided on design, safety, handling, and storage of these items.

Lithium batteries with a number of chemistries, sizes, and construction details are widely used today, and due to a variety of factors can present hazards if improperly designed, manufactured, tested, handled, used, or stored.

Compliance with the requirements contained within this standard is recommended as a means of assuring that the cell or battery will perform its intended function(s) safely under conditions encountered in routine aviation operations. To ensure safe operation on the aircraft, it is imperative that users of this standard thoroughly understand the aircraft performance requirements (which establish the operating environments for end items) and the capabilities and limitations of the batteries and battery systems which power those end items. It is the equipment installers' responsibility to ensure that the batteries and battery systems meet the certification and installation requirements of the aircraft. Any regulatory application of this standard is the sole responsibility of the certifying civil aviation authority.

1.2 Scope

This standard applies to non-rechargeable (primary) lithium cells, batteries and battery systems individually or as part of a higher assembly, such as cells in a battery or batteries in end items used on aircraft.

For the purpose of this standard any reference to a cell or battery means a non-rechargeable lithium cell or non-rechargeable lithium battery that is undischarged unless stated otherwise in test procedures.

Rechargeable cells, batteries and battery systems used in a non-rechargeable manner are not covered by this Standard.

Additional evaluation by the certifying civil aviation authority is required if end items contain more than one battery (single cell or multiple cells).

1.3 Deleted (Inclusions In This Document)

1.4 Specific Exclusions from This Standard

Specific types of non-rechargeable cells, batteries and end items are partially or completely excluded from coverage under this standard, as listed here.

a. Reserve batteries are outside the scope of this standard. Certification for these excluded types **shall** be sought via other regulatory documents.

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b. Small cells or batteries as listed below:

1. Cells or batteries that are in button or coin format containing less than 2 Watt-hours (Wh) of capacity per manufacturer's specification and that are compliant with UL 1642 and the UN transport regulations [Reference 10] are excluded from this standard. These cells or batteries have sufficiently low energy that the risk to the aircraft is low.

2. Cells or batteries containing less than 5 Wh of capacity per the manufacturer's specification and that are compliant with UL 1642 and the UN transport regulations [Reference 10] and that are not mentioned in item a. are excluded from section 2.2.1 Cell Functional and Safety Requirements, and 2.2.2 Battery Functional and Safety Requirements in this standard.

c. Batteries composed of cells that are not individually available such as the cells within ANSI-1604LC format 9-volt batteries are excluded from this standard.

1.5 Regulatory Issues

Regulation of equipment to be installed in aircraft, and component parts of that equipment, is the responsibility of the certifying civil aviation authority. In the case of equipment installed in aircraft at the time of manufacture of the aircraft, the aircraft's Type Certificate (TC) specifies the approved aircraft type design including any battery or battery system. Amendments and Supplemental Type Certificates (STC) may be approved subsequent to the original issue of a TC.

The appropriate regulatory authority that governs Hazardous Materials Transportation will regulate the carriage of certain materials, for example non-rechargeable lithium battery and battery systems, in either passenger or cargo aircraft regardless of whether the materials are part of an item of equipment which is being carried as cargo.

Cells or batteries that have greater than 2 Wh and less than 5 Wh of capacity per the manufacturer's specification and are tested within the end item need to be identified as a component within the end item. The cell or battery need to have a notation in the manufacturer's documentation that the cell or battery is not to be used in any other end item unless tested separately in that end item. The end item configuration control documentation need to state that the cell or battery is approved based solely on the fact that it was tested and validated within the approved end item.

1.6 Test Procedures

The test procedures specified in section 2.4 of this standard provide a required means of demonstrating compliance with the performance and safety requirements defined in section 2.2.

a. Functional Tests

Functional test procedures and associated limits in this standard provide a laboratory-based means of assuring that functional performance will be satisfactory under the environmental conditions expected to be encountered in actual aviation operations.

b. Safety Tests

The safety test procedures and associated evaluation criteria described in section 2.4 provide a laboratory-based means of demonstrating compliance with the requirements of section 2.2. Test results may be used by equipment manufacturers as design guidance, for

monitoring manufacturing compliance and in certain cases for obtaining formal approval of equipment designs.

1.7 Safety Considerations

Safety is a major consideration in the use of lithium cells and batteries in aviation equipment. The education of end users and personnel involved in the assembly, handling, installation, maintenance, and disposal of non-rechargeable lithium batteries and battery systems as to their unique hazards and characteristics is a necessary aspect of effective lithium battery safety training. Safety is stressed because energetic and hazardous materials are used in the construction of lithium cells. Safety concerns include the possibility of fire, explosion, electric shock and the release of toxic or flammable gases.

Non-rechargeable lithium cells and batteries have high energy content per unit weight and per unit volume; thus, they may pose a potential safety hazard if not operated within design limitations throughout their complete life cycle. Hazards may also exist during testing which exceeds operational or design limits. Manufacturing flaws may introduce the possibility of hazards which are not related to mishandling or improper operation.

1.8 Definition of Terms

Throughout this standard, statements containing “should" are considered to provide guidance and are not subject to verification, however statements which contain “**shall**” are required and will be verified.

Key terms and definitions used in this standard may be found in the Glossary.

1.9 Storage

Non-rechargeable lithium cells, batteries and battery systems, and end items should be stored in temperature and humidity-controlled environments as specified or recommended by the cell or battery manufacturers. If specific recommendations are not provided by a cell or battery manufacturer, they should be requested. In general, cells and batteries should be stored in a dry and well-ventilated area and should be stored separated from flammable materials. Humidity or temperature control is not necessary in most instances but, to minimize loss of capacity through self-discharge, the temperature should be maintained between 10°C and 35°C. Generally, exposure to temperatures above 50°C should be limited to a few days per year. Cell and battery storage temperatures above 60°C are to be avoided. Do not store cells or batteries loosely in bins or on electrically conductive surfaces.

1.10 Shipping

The transport of non-rechargeable lithium batteries and battery systems is regulated. Prior to shipping non-rechargeable lithium batteries, consult the most current regulations such as the United Nations’ Dangerous Goods Regulations (DGR) section 38.3, UN 3090, and UN 3091 [References 10, 11, 12] and the most current regulations of the affected regulating country. In the United States (all modes of transportation): Title 49, Code of Federal Regulations parts 100-185 governs transportation.

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