

Specification for

Primary active lithium batteries for use in aircraft

Confirmed December 2009

Foreword

This edition of this British Standard, which has been prepared under the direction of the Aerospace Standards Policy Committee, introduces technical changes but it does not reflect a full review or revision of the standard, which will be undertaken in due course. It introduces revised and additional tests for primary lithium batteries to assist manufacturers to overcome difficulties experienced when implementing the previous standard. It supersedes BS G 239 : 1987 which is withdrawn.

This British Standard specifies requirements and tests for type approval and quality assurance for primary lithium batteries designed for use in aircraft and specifies general design requirements applicable to such batteries. Examples of an individual specification sheet and form of Declaration of Design and Performance are given in annexes A and B. Methods of determining electrical performance, including service output, are included. It is not the purpose of this standard to specify particular sizes but a range of chemical systems based on lithium is covered.

The type approval tests contained in this British Standard include an evaluation of intrinsic safety. Additionally, guidance for users of batteries is included in annex C.

This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Contents

	Page
Foreword	Inside front page
Committees responsible	Back page
Specification	
1 Scope	2
2 References	2
3 Definitions	2
4 Individual specification sheet	2
5 Identification and marking	3
6 Design	3
7 Type approval	4
8 Electrical tests	7
9 Environmental tests	7
10 Storage tests	8
11 Safety tests	9
12 Quality assurance	11
Annexes	
A (normative) Example of an individual specification sheet	13
B (informative) Example of form of Declaration of Design and Performance	14
C (informative) Guidance for battery users	17
Tables	
1 Typical chemical systems used in primary active lithium batteries	2
2 Test levels	9
Figures	
1 Type approval test programme	5
2 Suggested support method for cylindrical and rectangular cells	12
List of references	Inside back page

Specification

1 Scope

This British Standard specifies design, type approval and quality assurance requirements for all primary active lithium batteries for use in aircraft.

NOTE 1. Typical examples of the chemical systems employed in the cells from which the batteries are constructed are given in table 1.

NOTE 2. The manufacturer is encouraged to refer the purchaser to the information contained in annex C.

Table 1. Typical chemical systems used in primary active lithium batteries	
Chemical system	Nominal voltage V
Li-SOCl ₂ (lithium-thionyl chloride)	3.5
Li-MnO ₂ (lithium-manganese dioxide)	3.0
Li-(CF _x) _n (lithium-polycarbon monofluoride)	3.0
Li-SO ₂ (lithium-sulfur dioxide)	3.0
Li-Cu ₄ O(PO ₄) ₂ (lithium-copper oxyphosphate)	2.5
Li-CuO (lithium-copper oxide)	1.5
Li-FeS ₂ (lithium-iron disulfide)	1.5

2 References

2.1 Normative references

This British Standard incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back page. Subsequent amendments to, or revisions of, any of these publications apply to this standard only when incorporated in it by updating or revision.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back page, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the following definitions apply.

3.1 nominal voltage

The value of voltage assigned to a battery type for the purpose of identification or classification.

3.2 end-point voltage (V_E)

The on-load voltage at which the discharge is considered complete, as defined in the individual specification sheet.

3.3 operational temperature limits (T_H , T_L)

The maximum temperature T_H and minimum temperature T_L between which the battery is designed to be used and to comply with this standard as defined in the individual specification sheet.

3.4 duty discharge requirements

The electrical load demands of the application for which the battery is intended, expressed in terms either of resistance, current or power versus time.

3.5 duty discharge duration (N_L , N , N_H)

The duration for which the battery, at a temperature of T_L , 20 °C or T_H respectively, is required to perform its duty discharge in accordance with 3.4, down to the end-point voltage V_E , and as defined in the individual specification sheet.

3.6 rated capacity (C_r)

The product of the constant current equivalent to the mean of the duty cycle current and the discharge time at 20 °C down to the end-point voltage V_E , as defined in the individual specification sheet.

3.7 voltage delay time (D)

The maximum time interval between the application of the duty discharge load and the terminal voltage reaching and sustaining a value not less than V_E , as defined in the individual specification sheet.

3.8 cell

An individual electrochemical unit.

3.9 battery

An assembly consisting of one or more cells.

3.10 centre of cell

- for a cylindrical cell, the mid-point of the length of the cell;
- for a coin cell, the centre of one face of the cell;
- for rectangular and irregular shaped cells, the centre of the side with the largest surface area.

4 Individual specification sheet

The manufacturer shall prepare an individual specification sheet for each type of battery produced. The individual specification sheet shall define the values for parameters given in annex A.

5 Identification and marking

5.1 At least the following information shall be clearly and indelibly marked on the battery casing, except for those batteries referred to in **5.2**:

- a) 'LITHIUM BATTERY' (in block capitals);
- b) chemical system employed (words or chemical symbols);
- c) manufacturer's name or identification;
- d) manufacturer's type or part number;
- e) nominal battery voltage;
- f) 'CAUTION: *NEVER CHARGE, SHORT CIRCUIT, PUNCTURE, DEFORM OR INCINERATE. REMOVE WHEN DISCHARGED.*' (in block capitals);
- g) 'Positive terminal polarity'.

5.2 Where lithium batteries are too small to incorporate all the information required by **5.1**, such batteries shall, at a minimum, be identified by the items detailed in **5.1d** and **5.1g**, and the full information required by **5.1** shall accompany the battery on a separate leaflet.

6 Design

6.1 General construction

NOTE. It is essential that the battery be constructed such that the risk of failure due to rough handling is minimized.

No cell interconnections shall be exposed such that they can be accidentally damaged or present a risk of electrical short circuit.

6.2 Battery case

The casing of the battery shall be of a material and form which satisfy the environmental tests given in clause **9**.

Additionally the material used shall be of low flammability such that it satisfies *Joint Airworthiness Requirements*, Part 25, paragraph 25.853(b)[1].

The manufacturer shall define on the individual specification sheet the method of in-service mounting employed for the type tests. Any restrictions on the method of mounting shall be declared on the Declaration of Design and Performance (**6.10**) under 'Limitations'.

6.3 Venting

All cells shall incorporate a pressure relief mechanism or shall be so constructed that they will relieve excessive internal pressure at a value and rate which will preclude explosion or self-ignition. If encapsulation is necessary to support the cells within the outer case, the type of encapsulant and the method of encapsulation shall not cause the battery to overheat under normal operation nor inhibit the operation of the pressure relief mechanism.

The battery case material and/or its final assembly shall be so designed that, in the event of one or more cells venting, the battery case does not present a hazard in its own right.

6.4 Protective devices

6.4.1 General

Batteries shall be so designed that they do not present a safety hazard under all normal and electrically abusive conditions of use.

NOTE. To meet this requirement it may be necessary to provide the devices specified in **6.4.2** to **6.4.4**.

When the devices specified in **6.4.2** to **6.4.4** are provided, they shall:

- a) form an integral part of the battery;
- b) not be susceptible to short-circuiting or any failure which will allow them to be bypassed;
- c) not be replaceable by the user;
- d) be rated such that the reliable operation of the battery over the full range of operating and environmental conditions is not inhibited.

6.4.2 Overload protection

The battery shall comply with the short circuit requirement (see **11.7**).

NOTE. This may be achieved by the incorporation of a suitable device.

6.4.3 Charge protection

Where the possibility of external charging exists, the battery shall be provided with a series diode or other protective device. Parallel-connected series strings of cells in a battery shall be protected from internal charge by the inclusion of a series diode or other device in each string.

6.4.4 Reverse polarity

The battery shall comply with the forced discharge requirement (see **11.4**) by the inclusion of a shunt diode or other device across each cell, if necessary.

6.5 Electrical outputs

Single voltage output batteries shall be employed wherever possible. Batteries shall not derive multi-voltage outputs by means of series chain tapings.

6.6 Electrical terminals

Output terminations shall be mechanically polarized. If flying leads are employed, these shall be made from an approved aircraft cable and be suitably terminated to prevent accidental discharge.

NOTE. It is essential that the output terminations be shrouded so as to minimize the risk of an electrical short circuit.

6.7 Attitude

Batteries shall be suitable for operation in any attitude.

6.8 Fixing

Batteries shall be provided with means of attachment to the structure unless they are designed to be closely fitted within an equipment.

6.9 Environmental conditions

6.9.1 Temperature

The battery shall be suitable for operation over at least the temperature range T_L to T_H and shall not be deranged by exposure (non-operation) to the temperature range $-40\text{ }^{\circ}\text{C}$ to $75\text{ }^{\circ}\text{C}$ or the temperature range specified in the individual specification sheet.

6.9.2 Altitude

The battery shall be suitable for operation over the altitude/pressure range -457 m (-1500 ft), 106.94 kPa to $+16\,764\text{ m}$ ($+55\,000\text{ ft}$), 9.12 kPa on the pressure range specified in the individual specification sheet.

6.10 Declaration

A Declaration of Design and Performance shall be prepared for each battery type.

NOTE. The format in annex B is strongly recommended and should be used unless otherwise required by the Design Authority.

7 Type approval

7.1 General

7.1.1 Type approval of a battery shall be based upon the tests given in clauses 8, 9 and 10 as determined in the individual specification sheet and in clause 11. The manufacturer shall demonstrate to the satisfaction of the Approving Authority¹⁾ that the batteries comply with the requirements of this standard.

NOTE 1. The Approving Authority will signify type approval of the battery by the issue of the appropriate certification.

NOTE 2. The Approving Authority may, on a discretionary basis, grant an approval before the completion of the storage tests (clause 10) on the basis of an appropriate technical submission.

7.1.2 Except for those batteries detailed in 11.1, batteries subjected to type approval testing shall be to a defined build standard and be made using production tooling and assembly techniques and at the production plant at which production is intended. The manufacturer shall ensure that the plant is approved by the appropriate Quality Assurance Authority for the manufacture of the appropriate battery type. The type approval batteries shall in every way be representative of normal production and shall have successfully

passed at least the following production acceptance tests prior to submission for type approval.

a) *Dimensions and mass.* The dimensions and mass of the batteries shall be measured and shall comply with the controlled outline and interface drawings.

b) *Identification.* The information displayed on each battery shall comply with that required by the individual specification sheet and by clause 5.

7.1.3 Type approval of a battery to this standard shall relate solely to its use in the application(s) stated in the individual specification sheet; it shall not be taken as an approval for general application.

7.2 Type approval tests

7.2.1 The appropriate numbers of batteries shall be subjected to type approval tests in accordance with figure 1. No cell in any of the type approval test batch of batteries shall leak, vent or explode or in any other way discharge its contents except where subjected to the test in 11.1.

NOTE. Because of the long storage capability of the batteries covered by this specification, interim approval may be granted by the Approving Authority after the successful completion of all tests, excluding the long-term storage testing of batteries in excess of 1 year.

7.2.2 Unless otherwise specified in a given test, all tests shall be carried out at the prevailing temperature, pressure and humidity. Where these parameters are specified in a given test, the values given shall be subject to the following tolerances:

- | | |
|----------------------|-----------------------------------|
| a) temperature | $\pm 2\text{ }^{\circ}\text{C}$; |
| b) pressure | $\pm 1\text{ kPa}$; |
| c) relative humidity | $\pm 10\text{ }\%$. |

7.2.3 The test equipment used for the type approval tests shall, unless otherwise specified in this standard, have at least the following degree of accuracy and have a range appropriate to the quantity being measured.

- Voltmeters shall conform to BS 89 : Part 2 : 1990, class index 0.3.
- Ammeters shall conform to BS 89 : Part 2 : 1990, class index 0.3.
- Thermometers shall have an accuracy of $1\text{ }^{\circ}\text{C}$.
- Chronometers shall have an accuracy not exceeding $2\text{ }\%$ for periods less than 10 s , $0.5\text{ }\%$ for periods between 10 s and 24 h , and $0.1\text{ }\%$ for periods greater than 24 h .
- Resistors shall have an accuracy of $0.5\text{ }\%$ up to 100 W dissipation and $1.0\text{ }\%$ above 100 W dissipation.

¹⁾The Approving Authorities for batteries for British civil aircraft and military aircraft are, respectively, the Airworthiness Division of the Civil Aviation Authority (or a Design Authority approved by them) or the Ministry of Defence.

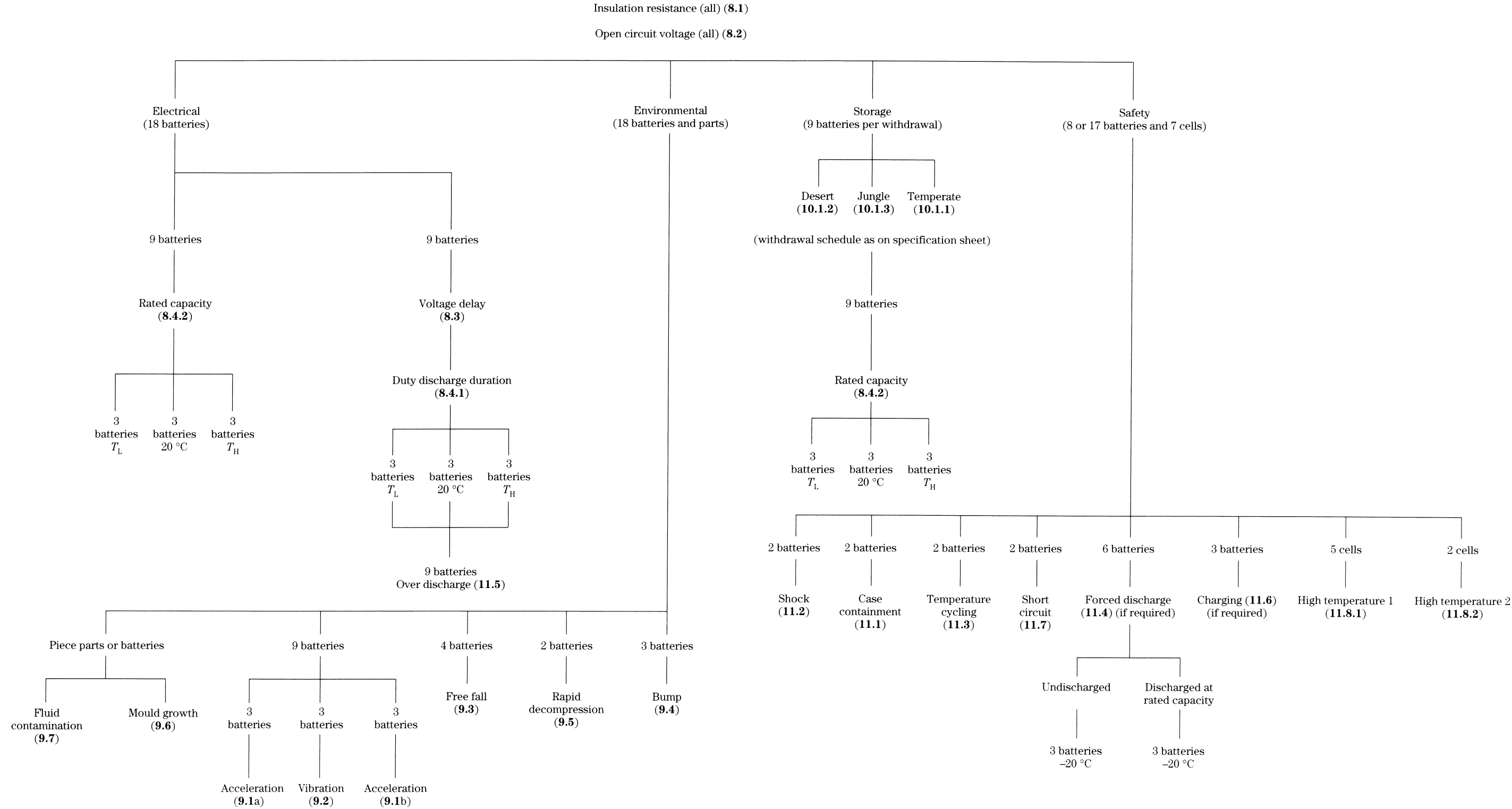


Figure 1. Type approval test programme