

Aircraft batteries —

Part 1: General test requirements and performance levels

The European Standard EN 60952-1:2004 has the status of a British Standard

ICS 29.220.20; 49.060

National foreword

This British Standard is the official English language version of EN 60952-1:2004. It is identical with IEC 60952-1:2004. It supersedes BS EN 60952-1:1993 which will be withdrawn on 1 November 2007. Together with BS EN 60952-2:2004 and BS EN 60952-3:2004, it supersedes BS 6G 205-1:1995, which is withdrawn.

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English version

Aircraft batteries
Part 1: General test requirements and performance levels
(IEC 60952-1:2004)

Batteries d'aéronefs
Partie 1: Exigences générales d'essais
et niveaux de performances
(CEI 60952-1:2004)

Flugzeugbatterien
Teil 1: Allgemeine Prüfanforderungen
und Leistungsmerkmale
(IEC 60952-1:2004)

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CENELEC

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Foreword

The text of document 21/611/FDIS, future edition 2 of IEC 60952-1, prepared by IEC TC 21, Secondary cells and batteries, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60952-1 on 2004-11-01.

This European Standard supersedes EN 60952-1:1993.

The changes made involve the inclusion of additional test requirements to meet the needs of the regulatory airworthiness authorities for both product performance and qualification.

It is recognised that additional data may be required by other organisations (national standards bodies, AECMA, SAE, etc.). The present standard can be used as a framework to devise tests for generation of the required data.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2005-08-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2007-11-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60952-1:2004 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61434	NOTE	Harmonized as EN 61434:1996 (not modified).
ISO 266	NOTE	Harmonized as EN ISO 266:1997 (not modified).
ISO 9000	NOTE	Harmonized as EN ISO 9000:2000 (not modified).

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INTRODUCTION

The IEC 60952 series defines minimum environmental and performance requirements for establishing a qualification standard for airworthiness of lead-acid and nickel-cadmium aircraft batteries, which contain corrosive electrolytes.

The series defines test procedures for determining battery performance. The electrical test results may be used to establish airworthiness in a particular application. For all tests, the manufacturer declares minimum performance for each battery type.

The requirements of IEC 60952 for aircraft batteries are divided into three parts:

- Part 1 defines test procedures for the evaluation, comparison and qualification of batteries and states minimum environmental performance levels for airworthiness.
- Part 2 defines the design requirements for aircraft batteries as well as the format (shape and size) for the battery as well as the range of aircraft interface connectors that are used.
- Part 3 defines the product specification which is used to define specific requirements for an application and a declaration of design and performance (DDP), which details the performance of a battery format when tested to Part 1.

AIRCRAFT BATTERIES –

Part 1: General test requirements and performance levels

1 Scope

This part of IEC 60952 defines test procedures for the evaluation, comparison and qualification of batteries and states minimum environmental performance levels for airworthiness. Where specific tests are defined with no pass/fail requirement (to establish performance capability), the manufacturer's declared values, from qualification testing, will be used to establish minimum requirements for ongoing maintenance of approval for that design of battery.

To provide representative examples, this standard utilises voltage and current values based upon an aircraft electrical system nominally rated at 28 V d.c. Additionally, the nominal values for cell voltage are assumed to be 1,2 V per cell for nickel-cadmium batteries and 2,0 V per cell for lead-acid batteries. It is important to note that when using this standard to evaluate products designed to operate on an aircraft electrical system other than the nominal 28 V d.c., or whose chemical properties are such that the individual cell voltage differs from that stated above, test values need to be adjusted accordingly.

The specific topics addressed in this part of 60952 serve to establish acceptable quality standards required to qualify a battery as airworthy and are divided into 2 classes (class I and II) as defined in Clause 3 of this standard.

- Most of the requirements of this Part 1 state the minimum performance level for class I applications which are also mandatory for class II applications.
- Subclauses 5.6 and 6.6 state 2 different levels of performance for class I and II applications.
- Clause 7 states special requirements for class II applications only.

In cases where a specific application demands testing and/or requirements exceeding those detailed in this standard the purchaser will detail said requirements in the product specification and the method of establishing compliance.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60051-1, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 1: Definitions and general requirements common to all parts*

IEC 60051-2, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 2: Special requirements for ammeters and voltmeters*

IEC 60925, *DC supplied electronic ballasts for tubular fluorescent lamps – Performance requirements*

IEC 60952-2:2004, *Aircraft batteries – Part 2: Design and construction requirements*

IEC 60952-3, *Aircraft batteries – Part 3: Product specification and declaration of design and performance (DDP)* ²⁾

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ISO 7137, *Aircraft – Environmental conditions and test procedures for aircraft equipment*

RTCA DO-160, *Environmental Conditions and Test Procedures for Airborne Equipment*

U.S. Federal Test Method, Standard No. 191A / Federal Test Method 5906, *Flammability (Horizontal Test)*

SAE AIR 1377A-80, *Fire Test Equipment for Flexible Hose and Tube Assemblies*

SAE AS 1055B, *Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings and Similar System Components*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

current values

values of current in ampere (A) used to charge and discharge cells and batteries, expressed as a multiple of the capacity

NOTE 1 For example, a current of 20 A used to charge a cell with a rated capacity C (Ah) of 100 Ah would be expressed as $C/5$ or $0,2 C$ (A).

NOTE 2 IEC 61434 is equally applicable to both nickel-cadmium and lead-acid and therefore the reference current (I_t) can be expressed as

$$(I_t)A = C_n Ah/1h$$

where C_n is the rated capacity declared by the manufacturer in ampere hours and n is the timebase in hours for which the rated capacity is declared.

3.2

1 rate I_1

current which the battery delivers to give not less than its rated C_1 capacity in 1 h

NOTE This is the basis on which all other current ratings are defined.

3.3

rated capacity

C_1

minimum capacity, expressed in Ah, obtained from a charged battery when discharged at the 1 I_1 rate to the end point voltage (see 3.8)

3.4

end of life capacity C_1

EOL

minimum capacity, expressed in Ah, obtained from a charged battery throughout its normal service life when discharged at the 1 I_1 rate to the end point voltage

²⁾ The first edition (1993) was published under the title *Aircraft batteries – Part 3: External electric connections*.

3.5**constant voltage current** I_{pr}

discharge current, which the battery delivers at the conclusion of a 15 s power discharge, controlled so as to maintain a constant terminal voltage of half the nominal voltage

3.6**peak power current** I_{pp}

discharge current at $t = 0,3$ s while testing as in 3.5

3.7**charged battery**

battery that has been fully charged in accordance with the battery manufacturer's instructions or as defined in the product specification

3.8**end point voltage****EPV**

unless otherwise stated, during discharge the battery end point voltage (EPV) corresponding to a mean voltage per cell of 1,00 V for nickel-cadmium or 1,67 V for lead-acid batteries

3.9**serviced battery**

battery that has been fully prepared and maintained in accordance with the manufacturer's instructions or as defined in the product specification

3.10**airworthiness**

compliance of a battery or part thereof with all conditions and regulations required by the appropriate governmental authorities for their safe operation and performance

3.11**product specification**

separate document which details the specific requirements which a battery is expected to meet for a particular aircraft application

3.12**class I battery**

battery classification covering batteries for general purpose applications, for which this standard provides a general guideline and the minimum requirement necessary to certify a battery as airworthy

3.13**class II battery**

battery classification covering batteries for special purpose applications, for which specific and more rigid requirement are specified by the user and are necessary to qualify a battery for use in an extreme climatic or operational environment

4 Test conditions and measuring apparatus

4.1 General test conditions

If specific test conditions are not defined for a test, the test shall be carried out under the following general test condition:

- Air pressure: 85 kPa to 106 kPa (850 mbar to 1 060 mbar)
- Temperature: 23 °C ± 2 °C
- Relative humidity (RH): not to exceed 70 %

If definite tolerances have not been specified, a deviation of not more than ±5 % from the given non-electrical values will be permitted.

4.2 Measuring apparatus

The measuring method used for the tests shall be selected to suit the magnitude of the parameters to be measured. The apparatus shall be regularly calibrated and shall have at least the degree of accuracy given below.

4.2.1 Voltage measurement

The instruments used for measuring voltage shall be voltmeters having an accuracy of class 0,5 or better, as defined in IEC 60051-1 and IEC 60051-2. Digital systems shall comply with IEC 60925. The resistance of the voltmeters shall be at least 5 000 Ω/V.

4.2.2 Current measurement

The instruments used for current measurement shall be ammeters having an accuracy of class 0,5 or better, as defined in IEC 60051-1 and IEC 60051-2. Digital systems shall comply with IEC 60925. This accuracy class shall be maintained for the assembly of ammeter, shunt and leads.

4.2.3 Temperature measurement

The instruments used for temperature measurement shall have an accuracy of ±1 °C or better.

4.2.4 Time measurement

The instruments used for time measurement shall be to an accuracy of 0,5 % or better.

4.2.5 Additional test equipment

Equipment used shall have a measurement accuracy of 5 % unless otherwise stated.

4.2.6 Mass test equipment

Equipment used shall have a measurement accuracy of 0,5 % unless otherwise stated.

4.3 Charging method

The battery shall be serviced and charged in accordance with the manufacturer's instructions or using the dedicated charger or as required in the product specification.

4.4 Physical examination

Prior to the commencement of the electrical and environmental testing, each battery being tested shall be inspected to ensure that it complies with the relevant product specification as defined in IEC 60952-3, or to the manufacturer's drawing as follows:

- a) mass and dimensions;
- b) minimum marking as detailed in 15.3 of IEC 60952-2;
- c) correct warning labels;
- d) correct interface connectors;
- e) damage to case, lid and interface connectors;
- f) no signs of corrosion;
- g) no signs of electrolyte leakage;
- h) general standards of workmanship.

5 Electrical requirements and test procedures

5.1 Capacity tests at the 1 I_1 rate

5.1.1 Rated capacity C_1

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, it shall be discharged at the 1 I_1 rate to its EPV, maintaining the ambient temperature at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ during discharge.

Requirement – The battery shall deliver a capacity of not less than 100 % C_1 (discharge time 1 h).

5.1.2 Capacity at 1 I_1 and $-18\text{ }^{\circ}\text{C}$

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $-18\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, it shall be discharged at the 1 I_1 rate to its EPV, maintaining the ambient temperature at $-18\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ during discharge.

Requirement – The capacity shall be recorded and shall not be less than the value declared by the manufacturer or stated in the product specification.

5.1.3 Capacity at 1 I_1 and $-30\text{ }^{\circ}\text{C}$

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ it shall be discharged at the 1 I_1 rate to its EPV, maintaining the ambient temperature at $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ during discharge.

Requirement – The capacity shall be recorded and shall not be less than the value declared by the manufacturer or stated in the product specification.

5.1.4 Capacity at 1 I_1 and $50\text{ }^{\circ}\text{C}$

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, it shall be discharged at the 1 I_1 rate to its EPV, maintaining the ambient temperature at $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ during discharge.

Requirement – The capacity shall be recorded and shall not be less than the value declared by the manufacturer or stated in the product specification.

5.2 Constant voltage discharge

Either of the following test methods shall be carried out as agreed by the approving authority. The discharge current capability of the test equipment must exceed $50 I_1$.

5.2.1 Constant voltage

Subject the battery to a constant voltage discharge equal to the number of cells multiplied by half their nominal voltage at the following temperatures.

5.2.1.1 Constant voltage current at 23 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $23\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a rate so as to maintain a constant terminal voltage corresponding to half the nominal voltage for not less than 15 s. The discharge load shall be automatically controlled to enable a plot of current against time to be recorded throughout the test.

Requirement – The current at 15 s shall be designated I_{PR} and the current at 0,3 s shall be designated I_{PP} . The values obtained shall be reported and shall not be less than the values declared by the manufacturer or as stated in the product specification.

5.2.1.2 Constant voltage current at –18 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $-18\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a rate so as to maintain a constant terminal voltage corresponding to half the nominal voltage for not less than 15 s. The discharge load shall be automatically controlled to enable a plot of current against time to be recorded throughout the test.

Requirement – The current at 0,3 s and 15 s shall be reported and shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.2.1.3 Constant voltage current at –30 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $-30\text{ °C} \pm 2\text{ °C}$, the battery shall be discharged at a rate so as to maintain a constant terminal voltage corresponding to half the nominal voltage for not less than 15 s. The discharge load shall be automatically controlled to enable a plot of current against time to be recorded throughout the test.

Requirement – The current at 0,3 s and 15 s shall be reported and shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.2.2 Constant voltage discharge (14 V)

Subject the battery to a constant voltage (14,0 V) discharge at the following temperatures

NOTE It shall be noted that testing equipment for high rate (14 V) must record data with a resolution of 0,1 s intervals.

5.2.2.1 Constant voltage current at 23 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $23\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a rate so as to maintain a constant terminal voltage of 14,0 V for not less than 60 s.

Throughout the test a plot of current against time shall be recorded.

Requirement – The current at 0,3 s, 5 s, 15 s and 30 s together with the average current for the 60 s of the test shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.2.2.2 Constant voltage current at – 18 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $-18\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a rate so as to maintain a constant terminal voltage of 14,0 V for not less than 60 s.

Throughout the test a plot of current against time shall be recorded.

Requirement – The current at 0,3 s, 5 s, 15 s and 30 s together with the average current for the 60 s shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.2.2.3 Constant voltage current at –30 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at $-30\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a rate so as to maintain a constant terminal voltage of 14,0 V for not less than 60 s.

Requirement – Throughout the test a plot of current against time shall be recorded; the current at 0,3 s, 5 s, 15 s and 30 s together with the average current for the 60 s shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.3 Rapid discharge capacity

5.3.1 Rapid discharge capacity at 23 °C

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $23\text{ °C} \pm 2\text{ °C}$, it shall be discharged at a 10 I_1 rate to its EPV.

Requirement – The capacity shall be recorded and shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.3.2 Rapid discharge capacity at $-30\text{ }^{\circ}\text{C}$

Test method – The battery shall be serviced and charged in accordance with 4.3. After standing for not less than 20 h and not more than 24 h at an ambient temperature of $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, a serviced and charged battery shall be discharged at a $10\text{ }I_1$ rate to an end voltage corresponding to a mean voltage per cell of 0,5 V for nickel-cadmium or 0,83 V for lead-acid, maintaining the ambient temperature at $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ during discharge.

Requirement – The capacity shall be recorded and shall not be less than the value declared by the manufacturer or as stated in the product specification.

5.4 Charge retention

Test method – The battery shall be subjected to 3 separate tests one at each of the 3 different temperatures defined, each to be undertaken sequentially.

Test temperature:

- a) $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- b) $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$
- c) $-28\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$

The battery shall be serviced and charged in accordance with 4.3. It shall be discharged according to 5.1.1 and the discharge duration shall be recorded (capacity 1).

It shall be recharged and, with the battery cover on, stored in an open circuit condition at the temperature defined above for a period of 28 days, after which it shall be removed from the thermal storage, allowed to stabilise to a temperature of $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and then discharged at the $1\text{ }I_1$ rate to its EPV (capacity 2).

Requirement – The capacity (capacity 2) and the percentage reduction of capacity (calculated from capacities 1 and 2) shall be recorded and shall comply with the value declared by the manufacturer or as stated in the product specification.

5.5 Storage

Test method – A new battery, as supplied by the manufacturer, shall be stored in temperate conditions ($20\text{ }^{\circ}\text{C} \pm 15\text{ }^{\circ}\text{C}$; humidity less than 70 %) for 24 months. Different storage periods may be specified either by the manufacturer or stated in the product specification.

Requirement – After storage, the battery shall be serviced and charged in accordance with 4.3. It shall then satisfy the test sequence in Table 3 for test battery in group V.

5.6 Charge stability

Test method – The battery shall be serviced and charged in accordance with 4.3. To facilitate temperature measurements of the battery, a thermocouple shall be connected to either an inter-cell or monobloc connector, near to the centre of the battery, fitted with any necessary instrumentation and placed in a chamber at $50\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for not less than 20 h and not more than 24 h, prior to commencement of the test. The battery shall remain in the chamber for the duration of this test and the airflow, across the working section of the chamber, shall be at a minimum speed of 0,45 m per second.