



AEROSPACE STANDARD

AS8033™

Issued 1981-02
Reaffirmed 2017-10

Nickel Cadmium Vented Rechargeable Aircraft Batteries (Non-Sealed, Maintainable Type)

RATIONALE

AS8033 has been reaffirmed to comply with the SAE Five-Year Review policy.

OUTLINE

1. PURPOSE
2. SCOPE AND DEFINITIONS
 - 2.1 Definitions
3. GENERAL REQUIREMENTS
 - 3.1 Electrical
 - 3.2 Nameplate Markings
 - 3.2.1 Safety
 - a. Explosive Gases in Overcharge
 - b. Short Circuit Power
 - c. Caustic Electrolyte
 - d. High Voltage Shock
 - e. Secure Installation Mounting
 - 3.2.2 Performance Ratings
 - 3.2.3 Operational Information
 - 3.2.4 Cell Markings
 - 3.3 Environmental Requirements
 - 3.3.1 Operational Shock
 - 3.3.2 Operational Vibration
 - 3.3.3 Humidity
 - 3.3.4 Inverted Operation
 - 3.3.5 Corrosion Resistance
 - 3.3.6 Fluids Resistance
4. MINIMUM REQUIREMENTS - SAFETY
 - 4.1 Explosion of Hydrogen/Oxygen Gases
 - 4.1.1 Purging System
 - 4.1.2 Ignition Sources
 - 4.1.3 Explosion Containment
 - 4.2 Fire
 - 4.2.1 Self Extinguishing Materials
 - 4.2.2 Purging of Smoke and Toxic Gases
 - 4.3 Cell Vents
 - 4.4 Dielectric Strength
 - 4.5 Battery Energy Leakage
 - 4.6 Crash Safety
5. MANUFACTURING PERFORMANCE RATING - STANDARD PROCEDURES
 - 5.1 Discharge Performance
 - 5.1.1 Capacity Delivery (Emergency Energy Source)
 - a. "C₁" - Rated Minimum Capacity at 23°C (73°F)
 - b. Capacity Derating (D_C) as a Function of Temperature (T)
 - c. Capacity Derating (D_C) as a Function of Discharge Rate Multiples (M)

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2017 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE values your input. To provide feedback on this
Technical Report, please visit
<http://standards.sae.org/AS8033>

Documents
Document Sharing Hub

- 5.1.2 Power Delivery (Engine Start Capability)
 - a. “ I_{mp} ” - Power Rating at 23°C (73°F)
 - b. I_{mp} Derating (D_I) as a Function of Temperature (T)
 - c. I_{mp} Derating (D_I) as a Function of State of Charge (S)
- 5.2 Charge Performance
 - 5.2.1 On Board-Constant Potential
 - 5.2.2 On Board-Constant Current to Voltage Cutoff
 - 5.2.3 On Board-Charge Voltage as a Function of Electrolyte Temperature
 - 5.2.4 Maintenance Reconditioning
- 5.3 Charge Retention - Storage
- 5.4 Supplemental Characteristics
 - 5.4.1 Battery Heaters
 - 5.4.2 Battery Cooling/Heating

1. PURPOSE

It is the purpose of this Aerospace Standard to provide for the definition of the requirements of vented type, rechargeable, Nickel-Cadmium batteries of the form generally used in aircraft. These batteries serve as power sources for engine starting and also function to provide a source of emergency back-up electrical energy for essential loads. This Aerospace Standard establishes minimum standards for those functional characteristics of the battery which are required to enhance the safety of both personnel and aircraft, insofar as it is dependent on the battery. It is the further purpose of this Aerospace Standard to delineate those characteristics which are utilized in the normal, non-emergency functions of the battery.

This Aerospace Standard defines the minimum acceptable functional characteristics where they pertain to safety related issues and outlines the responsibilities of the battery manufacturer, the systems designer and maintenance personnel to ensure that those safety functions are not compromised. This Aerospace Standard also defines the measurement methods whereby the manufacturer's rated values of normal performance functions may be confirmed. The requirements for manufacturer supplied nameplate data and additional application information are also defined.

It is the further purpose of this Aerospace Standard to delineate those battery related issues which Aircraft System designers and Aircraft maintenance personnel must consider in their respective tasks and about which they must receive design/maintenance information from the battery manufacturer.

2. SCOPE AND DEFINITION

The Nickel Cadmium battery covered by this Aerospace Standard is the type which is generally, although not exclusively, used for engine starting purposes in turbine-powered aircraft and/or on aircraft with turbine type Auxiliary Power Units. This turbine starting function requires high power delivery rates from the battery for 15 to 30 seconds or more for each engine start. This same battery may also be used at lower power delivery rates, as the final redundant source of emergency electrical energy for the operation of essential flight equipment for required periods of 30 to 60 minutes.

The battery generally consists of a group of plastic jarred cells contained within an enclosing battery case. They are electrically connected in series with each other and usually terminate in an electrical connector mounted in the case front wall. The battery case may be secured to the aircraft structure by any of a number of clamping techniques.

The outer or battery case is ventilated to purge it of gases, such as the hydrogen and oxygen produced in overcharge. This ventilation may be of the closed air circuit type which is accomplished by passing air through the case and then exhausting these gases overboard. An alternative method, which is used to purge these gases from the battery case, is to encourage their natural convective diffusion with the ambient air in the compartment which contains the battery, by use of relatively open construction of the battery case and cover.

2. (Continued)

The battery, while in service, is generally charged by one of two methods: 1) by direct electrical connection to the D.C. bus which in turn is supplied by a regulated/controlled "constant potential" source such as a D.C. generator, or 2) from a dedicated "constant current" source in a system whereby the battery response voltage controls the termination, and also possibly the reinitiation, of that charge current. The "control" voltage of the "constant current" charge system or the regulated supply voltage of the "constant potential" system, may be compensated, or automatically adjusted, according to cell temperature, in order to more accurately control the state of "full charge" and minimize the amount of water used during overcharge.

These batteries may be equipped internally with heaters, thermal switches, thermal sensors, etc. for performing various functions both inside the battery and/or in the aircraft/battery system. In addition, some battery types have air passages between cells with appropriate plenum chambers above and below the cells, for more positive responsive control of cell temperature, by the passage of conditioned air.

2.1 Definitions:

Battery - The complete cased assembly of interconnected electrochemical cells, ready for installation in the aircraft.

"C₁" - The numerical value of the minimum expected capacity in units of ampere hours, at a discharge rate of C₁ amperes (the one-hour rate), and a battery temperature of 23°C. C₁ is the rating which indicates the relative amount of available emergency electrical energy capability of a particular cell/battery design.

Capacity - The dischargeable ampere hours available from a fully charged cell/battery at any specified discharge rate/temperature condition.

Cell - The basic battery building block. An electrochemical storage device consisting of positive and negative plates, separator, gas barrier and electrolyte contained in a cell case (jar) with suitable electrical terminals for connection to additional cells.

Charging - The return of electrical energy to a battery and its storage in electrochemical form.

Discharging - The removal of electrical energy from a battery.

Electrolyte - The ionically conductive alkaline solution used in the nickel cadmium cell.

Gas Barrier - The ionically conductive film, between the cell plates, which forces all plate generated gases to the top of the electrolyte and prevents them from reaching plates of opposite polarity.

I_{mp} - The numerical value of discharge current capability of a battery at maximum power delivery, partway through a simulated turbine engine start. the I_{mp} rating indicates relative engine-starting power capability of the battery, and is the minimum value of I_{mp} expected from the fully charged battery at 23°C. For engine start system design purposes, the use of a straight line approximation between a terminal voltage of 1.2N volts at zero load current and 0.6N volts at I_{mp} Amps, tends to be slightly conservative in the first few seconds of discharge toward engine light-off.

Overcharging - The continued passage of electrical "charging" current after the cell plates are charged. It results in the generation of hydrogen and oxygen gases. The onset of overcharge is manifested in the form of a transition from negligible gassing to complete conversion of all (over) charge current to gas.

2.1 (Continued)

Potassium Hydroxide - The caustic material which is mixed with pure water to formulate the electrolyte solution which is used in nickel cadmium cells.

Reconditioning - The programmed electrical exercise, consisting of a discharge/charge cycle(s), which is periodically utilized to restore the capability of full energy and power delivery to a battery which has electrically deteriorated while in service. It may also include water replacement and mechanical cleaning procedures.

Self-Discharge - The decrease in the state of charge of a cell, not resulting from an applied useful load, over a period of time, normally due to internal electrochemical losses and accelerated by higher temperature.

Separator - Layer(s) of insulating material (conventionally a fabric) which provide electronic separation between electrically conductive cell plates of opposing polarities. It is placed adjacent to the gas barrier and provides physical support for the gas barrier material.

Vent Cap - The check valve component on top of a cell which regulates the maximum internal pressure which the cell jar will hold while preventing the entrance of atmospheric gases under conditions of fluctuating ambient pressures. It is removeable to allow water replacement to the electrolyte.

3. GENERAL REQUIREMENTS

3.1 Electrical:

The battery shall be provided with a means for electrically connecting it to an external circuit. This connection, along with its mating external circuit connector, the intercell connectors within the battery, and the internal cell components, shall be capable of carrying a short circuit current of approximately two times the rated value of I_{mp} for a period of at least 3 minutes without igniting an explosive H_2/O_2 mixture inside the cells or within the battery case. The battery is not required to be functional following a testing of this capability.

3.2 Nameplate Markings:

It is recommended that all nameplate markings also be reproduced in appropriate pilot or aircraft operating handbooks and aircraft maintenance manuals.

3.2.1 Safety - Required:

CAUTION notices related to personal or aircraft safety must be prominently and effectively displayed. They should communicate (1) the urgency of the caution, (2) the nature of the hazard, (3) the action required in order to avoid the hazard, and (4) first aid/antidotal information for hazard recovery. The following hazard subjects shall be treated and communicated with highly visible battery labeling.

- a. Explosive Gases in Overcharge: The situations treated shall include both maintenance reconditioning and in-aircraft handling. The actions treated shall include, as a minimum, smoking, open lights, room or container ventilation, effective case purging ventilation system/connections when installing, and arcs when connecting/disconnecting live loads.
- b. Short Circuit Power: This subject shall include, as a minimum, such factors as magnitudes of potential short circuit currents that may be expected. They shall also include warnings about the use of uninsulated tools, metal brushes or metal supported brushes in battery cleaning, and the fusing/welding of personal jewelry such as rings, bracelets, neck chains, etc.

3.2.1 (Continued)

- c. Caustic Electrolyte: This subject shall include, as a minimum, such actions as proper maintenance of vent caps, precautionary opening of vent caps, and eye and face protection when opening. Antidote information shall include prompt water flushing of skin surfaces which have been contaminated with potassium hydroxide.

It shall also include immediate and extensive water flushing and medical attention following any instance of eye splash. The chemical constituents of the electrolyte used shall be displayed.

- d. High Voltage Shock: In those applications involving series connected batteries yielding system voltages greater than 40 to 50 volts, the subject of personal shock hazard shall be treated. Hazard factors here shall include the use of grounded battery circuit system with ungrounded battery cases, the high system voltage itself with exposed intercell connectors, and battery circuit to case leakage currents greater than 2 mA. Maintenance of cleanliness within the battery case shall be considered and stressed.
- e. Secure Installation Mounting: The subjects of continued secure mechanical restraint of this relatively heavy component, and the use of appropriate methods to ensure continued electrical connection in the aircraft, shall be treated.

3.2.2 Performance Ratings - Required:

The following performance and functional information shall be provided by the battery manufacturer on the exterior surface of the battery case in a permanent and legible form.

- a. Battery manufacturer's name and address.
- b. Battery rated capacity "C1" ampere hours.
- c. Battery rated I_{mp} amperes.
- d. Nominal battery voltage and number of cells.
- e. Battery polarity.
- f. Manufacturer's model or type designation.
- g. Battery maximum weight with electrolyte properly leveled.
- h. Nominal charging voltages at 23°C: V_{cp} , V_{co} and ΔV . (See Figure 6 and paragraph 5.2.2 for definition).
- i. If applicable - the heater voltage, current, and wiring diagram.
- j. If applicable - type, quantity and wiring diagram of thermal and/or voltage sensors employed.
- k. If applicable - Pressure/Air Flow requirements for forced air hydrogen purge designs.

3.2.3 Operational Information - Optional:

An abbreviated reconditioning procedure shall be supplied with or on each battery in a permanent form. It shall include the following information as a minimum.

- a. Manufacturer's recommended discharge and full recharge procedure for reconditioning and for appraising gas barrier functionality.
- b. Manufacturer's recommended cleaning procedures.
- c. Manufacturer's recommended water replacement method to include acceptable water purity requirements.
- d. A notice relative to the use only of tools approved for use with nickel cadmium batteries.
- e. A notice of the appropriate check and adjustment of aircraft on-board charger regulation.
- f. A notice of cleaning, maintenance, and reconnection of battery ventilation facilities in the aircraft.

3.2.4 Cell Markings - Required:

Batteries which are designed with replaceable cells require also that each cell be marked in a permanent manner to contain the following information:

- a. Cell polarity. (+ and/or -)
- b. Manufacturer's name and date code (month/year)
- c. Manufacturer's cell type number.
- d. Identification of rebuilt cells, the rebuilder, and rebuild date code (month/year)

3.3 Environmental Requirements:

The battery assembly shall be capable of meeting all the requirements of this standard following the application of all the following test procedures either described below or found in the referenced paragraph of RTCA* Document DO-160 which is titled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments".

3.3.1 Operational Shock:

Environmental Test Procedure paragraph 7.1 while in the normal upright position only.

3.3.2 Operational Vibration:

Environmental Test Procedure paragraph 8.2, category R or category W.

3.3.3 Humidity:

Environmental Test Procedure paragraph 6.0, category B.

*Radio Technical Commission for Aeronautics, Washington, D.C.