

Australian Standard[®]

**Secondary batteries for use with
stand-alone power systems**

Part 2: Installation and maintenance

This Australian Standard was prepared by Committee EL/5, Secondary Batteries. It was approved on behalf of the Council of Standards Australia on 21 April 1997 and published on 5 October 1997.

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Australian Automobile Association
Australian Automotive Aftermarket Association
Australian Chamber of Commerce and Industry
Australian Electrical and Electronic Manufacturers Association
Australian Lead Development Association
Electrical Development Association of New Zealand
Electricity Supply Association of Australia
Federal Chamber of Automotive Industries
Telstra Corporation

Additional interests participating in preparation of Standard:

Solar Energy Industries Association of Australia

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Part 2: Installation and maintenance

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL/5, Secondary Batteries. This Standard is the result of a consensus among Australian and New Zealand representatives on the Joint Committee to produce it as an Australian Standard.

It is the second part of a two-part Standard on stand-alone batteries. The two parts are as follows:

- (a) AS 4086.1, *Secondary batteries for use with stand-alone power systems, Part 1: General requirements.*
- (b) This Standard.

This Standard was prepared in response to requests from battery manufacturers and installers for a standard which specifically covers the installation requirements of stand-alone batteries.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Secondary batteries for use with stand-alone power systems

Part 2: Installation and maintenance

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard sets out recommended practices for the installation, maintenance, testing and replacement of secondary batteries, having nominal voltages not exceeding 115 V d.c., for use with stand-alone systems.

Stand-alone systems are systems that are not connected to the power distribution systems of an electricity supply authority. Stand-alone systems are supplied with power from one of a number of sources: a photovoltaic array, a wind generator, a water generator, or a diesel generator.

This Standard applies to the installation of all types of batteries including lead-acid and nickel-cadmium and covers both vented and valve-regulated cells.

NOTE: AS 3011.1 and AS 3011.2 cover requirements for batteries having nominal voltages exceeding 115 V d.c.

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

- | | |
|--------|---|
| 1006 | Solid-stem general purpose thermometers |
| 1319 | Safety signs for the occupational environment |
| 2184 | Low voltage switchgear and controlgear—Moulded-case circuit-breakers for rated voltages up to and including 600 V a.c. and 250 V d.c. |
| 2444 | Portable fire extinguishers and fire blankets—Selection and location |
| 2562 | Hydrometers—Portable syringe-type for lead-acid batteries |
| 2668 | Water for use in secondary batteries |
| 2669 | Sulphuric acid for use in lead-acid batteries |
| 2676 | Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings |
| 2676.1 | Part 1: Vented cells |
| 2676.2 | Part 2: Sealed cells |
| 3000 | Electrical installations—Buildings structures and premises (known as the SAA Wiring Rules) |
| 3011 | Electrical installations—Secondary batteries installed in buildings |
| 3011.1 | Part 1: Vented cells |
| 3011.2 | Part 2: Sealed cells |
| 3111 | Approval and test specification—Miniature overcurrent circuit-breakers |
| 3439 | Low-voltage switchgear and controlgear assemblies |
| 3439.1 | Part 1: Type-tested and partially type-tested assemblies |

AS

3947 Low-voltage switchgear and controlgear

3947.3 Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

Other documents

The Australian code for the transport of dangerous goods by road and rail.

1.3 DEFINITIONS For the purpose of this Standard, the definitions below apply.

1.3.1 Accessories—those items supplied with a battery to facilitate the continued operation of the battery.

NOTE: Such accessories include distilled water in containers, connectors, connecting bolts and nuts, and hydrometers.

1.3.2 Authorized person—the person in charge of the premises, or other person appointed or selected by the person in charge of the premises, to perform certain duties associated with the battery installation on the premises.

NOTE: In some states, work on low and medium voltage equipment may be undertaken by licensed personnel only.

1.3.3 Battery—a unit consisting of one or more cells connected in a series, parallel or series-parallel arrangement, to supply the voltage and current requirements of a connected load.

1.3.4 Battery enclosure—an enclosure containing batteries that is suitable for use in an area other than a battery room or an area restricted to authorized personnel.

1.3.5 Battery room—a room specifically intended for the installation of batteries.

1.3.6 Boost voltage—a controlled overvoltage, above float voltage, to provide a rapid partial recharge of a battery.

1.3.7 Capacity (C)—the quantity of electricity which a fully charged battery can deliver under specified conditions.

NOTE: Capacity is measured in ampere hours (A.h).

The capacity of a cell or battery is denoted by the symbol 'C'. As the capacity varies with rate of discharge, the symbol 'C' is followed by a numerical suffix giving the rate of discharge. Thus, C_{120} is the capacity in ampere hours at the 120 h rate of discharge. The specified temperature is usually 25°C. The final voltage depends on battery type and conditions of service.

Capacity may be specified as follows:

- (a) *Actual capacity*—the quantity of electricity in ampere hours that can be drawn from a cell or battery for a specific set of operating conditions including discharge rate, temperature, initial state of charge, age, and final voltage.
- (b) *Rated capacity*—the quantity of electricity in ampere hours, declared by the manufacturer, which a battery can deliver after a full charge under specified conditions.

NOTE: The specified conditions are rate of discharge, final voltage and temperature.

1.3.8 Capacity test—the discharge of a battery to a designated terminal voltage.

1.3.9 Cell—an assembly of electrodes and electrolyte which constitute the basic unit of a battery.

1.3.10 Charge/discharge rate—the current at which a battery is charged or discharged. This can be expressed in amperes or as a multiple of the rated capacity of the battery (see Clause 1.3.7). For example, if a battery is rated at 240 A.h at the 120 h rate of discharge and is being discharged at a current of 2 A, its discharge rate can be expressed as $0.0083C_{120}$.

1.3.11 Charging—an operation during which a battery receives electric energy, which is converted to chemical energy, from an external circuit. The quantity of electric energy is known as the charge, and is usually measured in ampere hours.

1.3.12 Constant current charge—a charge during which the current is maintained at a constant value.

1.3.13 Constant voltage charge—a charge during which the voltage across the battery terminals is maintained at a constant value.

1.3.14 Container—a container for the plate pack and electrolyte of a cell constructed of a material impervious to attack by the electrolyte.

1.3.15 Discharging—an operation during which a battery delivers current to an external circuit by the conversion of chemical energy to electric energy.

1.3.16 Duty cycle—the specified output of voltage or current to be achieved by the battery for a given period followed by a charge current to restore the battery charge to an acceptable level.

1.3.17 Electrolyte—a liquid or solid substance containing mobile ions which will render the substance ionically conductive: for example, sulphuric acid (H_2SO_4) in lead-acid batteries and potassium hydroxide (KOH) in nickel-cadmium batteries.

1.3.18 Electrolyte density—the density of the electrolyte measured in kilograms per cubic metre at a specific temperature (the density of pure water = 1000 kg/m^3 at 4°C).

NOTE: The density of the electrolyte was formerly indicated by its specific gravity. Specific gravity is the ratio of the density of the electrolyte to the density of pure water.

$$\text{S.G.} = \frac{\text{electrolyte density (in kilograms per cubic metre)}}{1000}$$

1.3.19 Equalizing charge—an extended charge to ensure complete charging of all the cells in a battery.

1.3.20 Extra-low voltage—not exceeding 115 V d.c.

1.3.21 Final voltage (cutoff voltage, end voltage)—the prescribed voltage at which a discharge is considered finished.

1.3.22 Float voltage—the voltage applied by the charging source to a battery in normal operation i.e. not in boost or equalizing mode.

1.3.23 Gassing—the formation of gas produced by electrolysis.

1.3.24 Inter-cell and inter-row connections—those connections made between rows of cells.

1.3.25 May—indicates the existence of an option.

1.3.26 Monobloc battery—a secondary battery in which two or more cells are fitted in a multi-compartment container.

1.3.27 Nominal voltage—a stated value of voltage used to identify a type of cell. For the purpose of this Standard, the nominal voltage of a lead-acid cell is 2 V and that of a nickel-cadmium cell is 1.2 V.

1.3.28 Output conductors—conductors from a battery to its load. Conductors connecting strings of cells in series are not output conductors.

1.3.29 Performance test—a test of the capacity carried out in order to compare the capacity of a battery with its rated value, or a previously measured value.

1.3.30 Pilot cell—a selected cell of a battery which is considered to be representative of the average state of the battery or part of the battery.

1.3.31 Prospective fault current—the highest level of fault current that can occur at a point in a circuit. This is the fault current that can flow in the event of a zero impedance short-circuit and if no protective devices operate.

1.3.32 Safety vent—a special design of vent plug which provides protection against internal explosion when a cell or battery is exposed to a naked flame or external spark.

1.3.33 Service life—the period of the useful life of a battery under specified conditions.

1.3.34 Service test—a special test of the ability of a battery to satisfy the design requirements (e.g. battery duty cycle) of the d.c. system.

1.3.35 Shall—indicates that a statement is mandatory.

1.3.36 Should—indicates a recommendation.

1.3.37 Shroud—an insulated cover to protect the terminals and inter-cell connectors from inadvertent contact by personnel, and accidental short-circuiting.

1.3.38 Terminal post—a part provided for the connection of a cell or a battery to external conductors.

1.3.39 Tiered stand—a stand on which rows of containers are placed above containers of the same or another battery.

1.3.40 Transit plug—a special plug fitted to the cells for transit.

1.3.41 Vent plug—a part closing the filling hole which is also employed to permit the escape of gas.

SECTION 2 BATTERY ACCOMMODATION AND ARRANGEMENT

2.1 GENERAL The major considerations in the design of a battery installation are—

- (a) the size and type of battery; and
- (b) the ratings and types of switchgear and conductors.

The size and type of battery depend upon the requirements and function of the d.c. system of which the battery is a part.

The major considerations in switchgear and conductor selection are as follows:

- (i) Rated operational voltage.
- (ii) Rated continuous current of switchgear.
- (iii) Fault current levels.
- (iv) Rated making and breaking current of switchgear.

NOTE: Appendix A provides guidance on a number of matters that should be considered when designing a stand-alone battery system.

2.2 CONNECTION BETWEEN BATTERY AND DIRECT CURRENT SWITCHBOARD

2.2.1 General Any cable, busway or busbar forming the connection between a battery terminal and a d.c. distribution board should be rated to withstand the prospective short-circuit current which the battery is able to deliver for a period of at least 1 s (see Appendix H).

2.2.2 Cables Cables should be effectively clamped and sufficient support should be provided throughout the length of cables to minimize sag, and prevent undue strain from being imposed on the cables or on battery terminals or other parts of the installation. Cables shall not be bent through a radius less than the minimum bending radius specified by the cable manufacturer.

2.2.3 Inter-cell and battery terminal connections Electrical connections between cables on separate levels or stands should be made so as to minimize mechanical strain on the battery posts.

Inter-cell connector shrouds are recommended to prevent accidental short-circuits on the battery. The shrouds should have access holes for meter probes.

Inter-cell and battery terminal connections should be constructed of materials either intrinsically resistant to corrosion or suitably protected by surface finish against corrosion. The joining of materials that are incompatible in a corrosive atmosphere should be avoided.

2.3 OVERCURRENT PROTECTION The output conductors of a battery shall be protected against overcurrent by a fuse or circuit-breaker in at least one output conductor. A battery which does not have either output conductor connected to earth shall be provided with a fuse or circuit-breaker in each output conductor.

Rewirable fuses shall not be used for this purpose because they can initiate fires and explosions.

Protective devices should be selected from the following:

- (a) Fuses, in accordance with AS 3947.3.
- (b) Combination fuse-switch units incorporating HRC fuses, in accordance with AS 3947.3.

- (c) Miniature circuit-breakers (MCBs), in accordance with AS 3111 or moulded case circuit-breakers (MCCBs), in accordance with AS 2184.

MCBs and some MCCBs have limited short-circuit current ratings and may require to be backed up by HRC fuses.

The installation should be arranged so that it is possible to completely isolate the battery.

2.4 THERMAL RUNAWAY A badly designed installation having poor cooling ventilation, no temperature correction or no voltage limitation in the charging system can result in thermal runaway of valve-regulated cells. This can result in fires and possible loss of the battery. The battery supplier should be consulted as to the appropriate installation design.

2.5 ALARMS It may be desirable to provide alarms indicating overcurrent or overvoltage conditions, or alternatively, the battery charger may automatically shutdown if overcurrent or overvoltage conditions occur.

It is desirable to receive an early warning of high or low battery voltage for the following reasons:

- (a) An indication of low battery voltage warns against—
- (i) discharging the battery to an extent that is unsuitable for normal operation of the load; and
 - (ii) maintaining the battery in a discharged condition.

Either of the above will shorten the life of cells, particularly cells of lead-acid batteries.

- (b) An indication of high battery voltage warns against overcharging the battery and reduces the risk of damage to battery-charging equipment.

When a battery is receiving a charge (other than a float charge), suitable detectors should monitor the battery voltage so that when the battery reaches full charge either the charge rate is reduced automatically, or an alarm is initiated.

When a battery is receiving a float charge, suitable detectors should monitor the battery voltage and initiate an alarm if the voltage exceeds or falls below the normal operating voltage limits of the rectifier or generator which is permanently connected in parallel with the battery.

Detection devices should incorporate a time delay to avoid spurious operation of alarms by transient voltages.

2.6 BATTERY ENCLOSURE

2.6.1 General Batteries shall be protected by means of a suitable enclosure. This may take the form of a box, a room or steel wire mesh. It should be clean, dry, adequately ventilated, and provide and maintain protection against detrimental environmental conditions.

2.6.2 Layout and location Batteries shall be located in accordance with the manufacturer's recommendations. The following additional considerations apply to the battery location:

- (a) Arc-producing devices shall not be located in areas where hydrogen concentrations can become significant, e.g. directly above battery cells.
- (b) The design of the battery installation should be such that localized heat sources such as sunlight, generators, steam pipes, walls exposed to direct sunlight and space heaters are avoided.

- (c) Extreme ambient temperatures should be avoided because low temperatures decrease battery capacity and prolonged high temperatures shorten battery life.
- (d) The enclosure location shall provide adequate structural support and be as free of vibration as possible.

NOTE: AS 2676.1 and AS 2676.2 provide guidance on the construction of battery enclosures.

- (e) The battery location should preclude contamination of water supplies and damage to equipment in the event of electrolyte spillage.
- (f) A battery should not be located near combustible material or near metal objects capable of falling across battery terminals and causing a short-circuit.

2.6.3 Mechanical considerations The following matters should be taken into consideration in the design of the enclosure:

- (a) The size of the enclosure should allow for sufficient clearance around the battery to provide access for installation and maintenance. Consideration should be given to the space required for safety equipment and handling equipment.
- (b) The supporting surface of the enclosure shall have adequate structural strength to support the battery weight and its support structure.
- (c) The enclosure should be resistant to the effects of electrolyte, either by selection of materials used or by appropriate coatings. Provision should be made for the containment for any spilled electrolyte.
- (d) Any enclosure doors should allow unobstructed exit.
- (e) The enclosure design should include appropriate means to prevent access by persons not aware of the hazards of battery banks.

2.7 VENTILATION

2.7.1 General All battery installations, for both vented and valve-regulated batteries, should be supplied with either natural or forced ventilation.

All secondary cells generate hydrogen and oxygen gases during charging. The major release of hydrogen gas occurs after a cell has achieved 95% of charge, or during any boost charging or overcharging of the battery.

The chemistry of a valve-regulated battery operates on an internal oxygen-recombination cycle which is arranged to suppress hydrogen gas evolution. Under normal operating conditions, hydrogen gas evolution and venting in valve-regulated cells is much lower than the hydrogen gas released by conventional vented (flooded) cells. The hydrogen suppression efficiency in valve-regulated batteries varies with cell technology, but typically exceeds 80% for gel cells and 90% for absorbent glass mat cells.

However, under conditions of overcharge or electrical abuse, significant amounts of hydrogen gas can be generated and emitted from valve-regulated cells. Further, the thermal management of valve-regulated cells under charge is more critical than for vented cells, and generally the valve-regulated cell will be irreversibly damaged when subjected to sustained electrical abuse, therefore, the manufacturer's recommended charging regime for valve-regulated batteries should be observed.

2.7.2 Rate of hydrogen evolution The average hydrogen concentration by volume in a battery enclosure shall be maintained below 2%.