



Maintenance-free Lead Acid Batteries

Requirements and test methods

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Guidelines for Alarm Systems

Maintenance-free Lead Acid Batteries

Requirements and test methods

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1 General

1.1 Scope

These guidelines are valid for maintenance-free lead acid batteries with fixed electrolyte used in alarm systems for application in stationary systems. The guidelines contain requirements and test methods.

These guidelines shall be applied in conjunction with the “guidelines for intruder alarm systems, general requirements and test methods“, VdS 2227 and the “guidelines for intruder alarm systems, protection against environmental influences, requirements and test methods“, VdS 2110.

1.2 Validity

These guidelines are valid from 01. July 2001; they replace the edition VdS 2102 1984-01 (01). This edition may be used for a transition period until 31. December 2001.

Note: This is a translation of the German guidelines; if there are any discrepancies, the German version shall be binding.

2 Normative references

These guidelines contain dated and undated references to other publications. The normative references are cited at the appropriate places in the clauses, the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to these guidelines only when announced by a change of these guidelines. For undated references the latest edition of the publication referred will be applied.

- **VdS 2110** Guidelines for intruder alarm systems, protection against environmental influences, requirements and test methods
- **VdS 2227en** Guidelines for intruder alarm systems, general requirements and test methods
- **VdS 2344en** Procedures for testing and the approval of equipment, components and systems used in fire protection and security systems

3 Terms and formulars

3.1 Terms and definitions

In the following the terms listed in clause 2 of “Guidelines for intruder alarm systems, general requirements and test methods“, VdS 2227 are repeated in parts.

Battery: Rechargeable electric energy source (secondary battery or accumulator).

Battery voltage: The voltage between the two terminals of a battery (accumulator).

Final voltage (cut-off voltage): The specified voltage at which a discharge of a battery is considered finished.

Discharge current: Current during discharging in Ampere [A]. Typical values are:

I_{10} = discharge current for a period of 10 hours relating to the nominal capacity

$$I_{10} = \frac{C_{Nenn}}{10 \text{ h}} \text{ in [A]}$$

I_{20} = discharge current for a period of 20 hours relating to the nominal capacity

$$I_{20} = \frac{C_{Nenn}}{20 \text{ h}} \text{ in [A]}$$

Conservation charging: A battery which is permanently kept in a charged condition to compensate charge losses (the terms floating operation of charging or stand-by operation mode are also in use).

Alarm System (AS): System which automatically or non-automatically signals hazard situations (e.g. Intruder Alarm System, Automatic Fire Alarm System).

End-of-charge voltage: The voltage of a battery during charging at a specified constant current when a battery has completely been charged.

Charge current: Current, expressed in hours [A]. Typical values are:

$$3 \times I_{10} = \text{maximal charge current} \quad 3 I_{10} = \frac{3 \times C_{Nenn}}{10 \text{ h}} \text{ in [A]}$$

Capacity: Capacity is the electrical charge expressed in Ampere-hours (Ah), which a fully charged battery may provide. The capacity C depends on the use (discharge time, discharge current, end-of-charge voltage and temperature).

Nominal capacity: Expressed in Ampere-hours [Ah]. The nominal capacity C_{Nenn} – also named C_{20} – is defined – if not otherwise indicated – normally as a discharge of 20 hours at an ambient temperature of 20 °C up to a final voltage (cut-off voltage) of 1.75 V/cell.

The nominal capacity is specified by the manufacturer.

Nominal voltage: Rounded battery voltage expressed in Volt [V]. The nominal voltage is depending of the number of cells connected in row (typical 6 V or 12 V).

Temperature compensation factor: Factor for adaptation of the end-of-charge voltage to the respective ambient temperature respectively temperature compensation. Typical value is a factor of $\pm 3 \text{ mV/cell/}^\circ\text{K}$ for floating operation of charging relating to a temperature of 20 °C.

Cell: Single resp. smallest element (cell) of a battery. The typical voltage of a cell of a lead battery is 2.0 V.

3.2 Formulars

The following formulars are used in the guidelines:

C_{Nenn}	Nominal capacity of a battery
C_S	Capacity after self-discharge of 90 days
C_T	Actual capacity of a battery
C_{20}	Capacity at a discharge of 20 hours
C_V	Loss of capacity (loss of charge)
c_{vt}	Percentage of capacity loss per day
I_{10}	Discharge current for a period of 10 hours
I_{20}	Discharge current for a period of 20 hours
$3 I_{10}$	Maximal starting charge current ($3 \times I_{10}$)

4 Requirements

4.1 Suitability

Batteries specified for the use in Alarm Systems shall be maintenance-free, sealed and suitable for the stand-by operation mode.

4.2 Construction

Maintenance-free batteries shall be designed mechanically stable and insensible against vibrations. The housing shall consist of impact protecting plastic or similar material.

4.3 Temperature range

Batteries shall have their full nominal capacity in a temperature range from 10 °C to 50 °C. In the temperature range between 0 °C and 10 °C a reduction of the capacity of max. 10 % of the nominal capacity is acceptable.

4.4 Marking

Batteries shall be marked unambiguously and durably with the name of the manufacturer, the battery type and the date of manufacturing. The date of manufacturing shall be determinable within a period of one month. Decisive for the marking is the date of the filling with electrolyte. For coded markings the manufacturer shall describe the marking in writing.

VdS-approved batteries shall be marked in addition on the outer side according to the requirements described in VdS 2344.

4.5 Terminals

Terminals of batteries shall be mechanically stable, corrosion-proof and constructed according to the maximal loading. Especially the respective counter contact and sufficient cross-section of the conductor is to be taken into consideration.

Terminals shall be marked durably with "+" and with "-".

4.6 Capacity

The capacity of batteries shall be at least 100 % of the nominal capacity C_{Nenn} after the first discharge cycle.

4.7 Cycle service life

After 50 charge/discharge cycles the batteries shall have a rest capacity of at least 80 % of the nominal capacity C_{Nenn} .

4.8 Life cycle

The batteries shall be designed for a life cycle of at least 4 years. After a conservation charging of 4 years the batteries shall have a rest capacity of at least 80 % of the nominal capacity C_{Nenn} .

4.9 Self-discharge

The self discharge of batteries shall not exceed 0.125 % of the real capacity C_T per day.

4.10 Conservation charging stability

Connected to a constant conservation charging voltage the battery shall be able of a constant charging without limitation of the current.

4.11 Independency of position

Batteries shall be fixed and sealed tightly and be designed so that they can be used completely independent of position. A gas pressure which is too high because of wrong handling or unprofessional charging shall be drawn off.

4.12 Deep discharge

Batteries shall be sufficiently secure against deep discharge. After a single discharge below the specified final voltage (cut-off voltage) within a time period up to one month the rest capacity shall be at least 95 % of the nominal capacity C_{Nenn} after charging.

4.13 Charging behaviour

Batteries shall have a good charging behaviour. After a 24-hours charge of a discharged battery with I_{20} the capacity shall be at least 90 % of the nominal capacity C_{Nenn} .

5 Test methods

5.1 Conditions for the tests

5.1.1 Environmental conditions for the tests

Unless otherwise specified, all tests are conducted under the following environmental conditions:

- Temperature 15 35 °C
- Relative humidity 45 75 %
- Atmospheric pressure 860 1060 hPa

5.1.2 Time measuring device

Unless otherwise specified the discharge time is recorded with a time measuring device (e. g. operation hours counter) with an exactness of at least ± 0.25 % of the measuring value.

5.1.3 Test samples

Six batteries per type are required for the tests of maintenance-free lead acid batteries. These are normally sampled by VdS staff at the warehouse or the manufacturing plant. Tests are carried out with new batteries, which are not older than 30 days after date of delivery of the manufacturer. Deviations from this may be agreed on a case-to-case decision.

Test will only be performed with complete and functional batteries.

5.1.4 Documentation

The following documentation shall be submitted for the tests:

- Technical data
- Material-/parts lists
- Drawings of the construction
- Description of the important functions
- Operation and user's manual

5.2 Test matrix

The individual tests are carried out according to the order of sequence specified by the following test matrix (see also annex A). If a specimen fails during the tests, a decision has to be taken on a case to case basis in co-operation with the manufacturer, if applicable, as to whether the test is continued and – if so – at which test stage.

Note: The sequence of tests in the test matrix is not identical to the sequence of clauses in these guidelines.

Test step	Test	Clause of these guidelines	Test specimen							
			1	2	3	4	5	6		
1	Initial tests	5.3	x	x	x	x	x	x		
2	Marking	5.4	x	x	x	x	x	x		
3	General tests	5.5	x	x	x	x	x	x		
4	Capacity	5.6	x	x	x	x	x	x		
5	Charging behaviour	5.7	x	x						
6	Cycle service life	5.10	x	x						
7	Temperature characteristics	5.8			x	x				
8	Deep discharge	5.11			x	x				
9	Self-discharge	5.9					x	x		
10	Long-term behaviour	5.12					x	x		

Table 5.01: Text matrix

5.3 Initial tests

It is tested if

- the batteries are made available for testing in correct performance and completely (including accessories as e. g. connecting screws),
- the required documentation according to clause 5.1.4 is in German language and completely available and is sufficient for testing,
- the batteries are functioning and in operational condition.

5.4 Marking

By a visual inspection it is intended to find out whether labelling is durable and clear readable and contains the following indications:

- Name of company (name of the manufacturer or distributor)
- Date of manufacturing (month and year)
- Type
- Nominal capacity in Ah resp. to a discharge of 20 hours
- Nominal voltage in V

The labelling shall indicate unambiguously manufacturer of the batteries resp. distributor and type of battery.

The date of manufacturing shall not be coded. For the user it shall be readable at what time (month and year) the battery was manufactured. For coded labelling the manufacturer shall indicate in another way the time (month and year) (e. g. by additional product information on the packaging).

Furthermore it is tested if the battery is marked „VdS-approved“ according to the requirements and if the marking is fixed on an easily accessible place.

Note: Eventually a further test will be necessary after finalizing the approval procedure.

5.5 General tests

It is tested if

- Batteries fulfil the requirements of these guidelines regarding suitability, construction/design and independence of position,
- the measurements, materials and weight correspond to the specifications in the technical documentation of the manufacturer,
- type, labelling, mechanical stability and maximal loading of the terminals are sufficient and correspond to the indications given by the manufacturer.

5.6 Capacity

5.6.1 Test temperature

The capacity of all batteries is measured at a temperature of (20 ± 5) °C.

Remark: The average temperature during the test shall be as close as possible to 20 °C.

5.6.2 Charge

The batteries will be discharged with I_{20} and in the following charged for 48 h with an end-of-charge voltage (2.3 ± 0.01) V/cell. The charge current is limited to a maximum of $3 I_{10}$.

5.6.3 Discharge

After a break of 2 hours the capacity will be ascertained with a discharge current of I_{20} . The current volume will be held constant during the whole discharge time at ± 1 %. The discharge process will be finalized when the specified final voltage (cut-off voltage) of typically 1.75 V/cell has been reached.

5.6.4 Determination of capacity

The discharge time is registered with a time measuring device (e. g. operation hours counter). The capacity of the battery is determined as follows: Discharge current (A) x discharge time (h) = battery capacity (Ah). The actual capacity C_T determined by this way shall at least be 100 % of the nominal capacity C_{Nenn} .

5.7 Charge behaviour

5.7.1 Test conditions

The testing of charging behaviour is made on two sample batteries at an ambient temperature of (20 ± 5) °C. The actual capacity C_T of these batteries determined according to clause 5.6 shall be each ≥ 100 % of the nominal capacity C_{Nenn} .

Remark: The average temperature during the test shall be as close as possible to 20 °C.

5.7.2 Charge

The batteries discharged with an I_{20} end-of-charge voltage of 1.75 V/cell are recharged for 24 h with a final voltage of (2.3 ± 0.01) V/cell. The charging current is limited to I_{20} .

5.7.3 Discharge

After a break of 2 hours the capacity will be ascertained with a discharge current of I_{20} . The current volume will be held constant during the whole discharge time at ± 1 %. The discharge process will be finalized when the specified final voltage (cut-off voltage) of typically 1.75 V/cell has been reached.

5.7.4 Determination of capacity

The discharge time is registered with a time measuring device (e. g. operating hours counter). The capacity is determined as follows: Discharge current (A) x discharge time (h) = battery capacity (Ah). The capacity such way determined shall be at least 90 % of the nominal capacity C_{Nenn} .

At a charging time of 24 h the batteries then are recharged (conditions as in clause 5.6.2 described).

5.8 Temperature characteristics

5.8.1 Test conditions

The temperature behaviour is tested on two samples in two test steps at an ambient temperature of each (10 ± 1) °C and (0 ± 1) °C according to clauses 5.8.2 and 5.8.4. The actual capacity C_T of each battery determined according to clause 5.6 shall be ≥ 100 % of the nominal capacity C_{Nenn} .

5.8.2 Charge

The with I_{20} discharged batteries are recharged in 48 h with an end-of-charge voltage - corresponding to the ambient temperature - of $(2.33 \pm 0,01)$ V/cell at (10 ± 1) °C and $(2.36 \pm 0,01)$ V/cell at (0 ± 1) °C (typically: factor of temperature compensating of ± 3 mV/cell/°C at a referring temperature of 20 °C). The charging current is limited to $3 I_{10}$.

5.8.3 Discharge

After a break of 2 hours the capacity will be ascertained with a discharge current of I_{20} . The current volume will be held constant during the whole discharge time at ± 1 %. The discharge process will be finalized when the specified final voltage (cut-off voltage) of typical 1.75 V/cell has been reached.

5.8.4 Determination of capacity

The capacity is registered with a time measuring device (e. g. operating hours counter). The capacity is determined as follows: Discharge current (A) x discharge time (h) = battery capacity (Ah).

The determined capacity shall at least be 100 % of the nominal capacity C_{Nenn} at an ambient temperature of (10 ± 1) °C respectively 90 % of the nominal capacity C_{Nenn} at an ambient temperature of (0 ± 1) °C.

5.9 Self discharge

5.9.1 Test conditions

The test on the self-discharge is made at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$ and at maximum 90 % relative humidity on two batteries. The actual capacity C_T of each battery as determined according to clause 5.6 shall be ≥ 100 % of the nominal capacity C_{Nenn} .

Remark: The average temperature during the test shall be as close as possible to 20 °C.

5.9.2 Charge and storage

The batteries are stored with open current cycle after a charging time of 48 h (conditions as described in clause 5.6.2 for 90 days).

5.9.3 Determination of discharge and capacity

Immediately after the 90 days storage the remaining capacity C_S is determined with a discharge current of I_{20} . The current is held constantly during the discharging time on ± 1 %. The discharging procedure is interrupted when reaching the end-of-charge voltage of 1.75 V/cell.

The discharging time is registered with a time measuring device (e. g. operation hours counter). The remaining capacity C_S is determined as follows: Discharging current (A) x discharging time (h) = battery capacity (Ah).

The capacity loss C_V is determined as follows taking into consideration the actual capacity C_T determined according to clause 5.6:

$$C_V = C_T[\text{Ah}] - C_S[\text{Ah}] \quad \text{in } [\text{Ah}]$$

The daily percental capacity loss c_{vt} is compared with the actual capacity C_T as determined according to clause 5.6 and determined as follows:

$$c_{vt} = \frac{C_V[\text{Ah}] \times 100 \%}{C_T[\text{Ah}] \times 90 \text{ d}} \quad \text{in } [\%/d]$$

The capacity loss c_{vt} shall not exceed 0.125 % per day.

5.10 Cycle service life

5.10.1 Test conditions

The test on the cycle service life is made on two batteries at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$. The actual capacity C_T of each battery as determined according to clause 5.6 shall be ≥ 100 % of the nominal capacity C_{Nenn} . The batteries are object to a series of 50 charging/discharging cycles.

Remark: The average temperature during the test shall be as close as possible to 20 °C.

5.10.2 Charge

The batteries are charged with a end-of-charge voltage of $(2,4 \pm 0,01)$ V/Cell for 16 h. The charging current is limited to $3 I_{10}$.

5.10.3 Discharge

After a break of 1 hour the capacity will be discharged with a discharge current of I_{10} . The current volume will be held constant during the whole discharge time at ± 1 %. The discharge process will be finalized when the specified final voltage (cut-off voltage) (typically 1.75 V/cell) has been reached.

5.10.4 Final charging

After the 50th discharging the batteries are charged with an end-of-charge voltage of $(2.3 \pm 0,01)$ V/cell for 48 h. The charging current is limited to $3 I_{10}$.

5.10.5 Final discharging

After a break of 2 hours the capacity will be ascertained with a discharge current of I_{20} . The current volume will be held constant during the whole discharge time at ± 1 %. The discharge process will be finalized when the specified final voltage (cut-off voltage) of typically 1.75 V/cell has been reached.

5.10.6 Determination of capacity

The discharging time is registered with a time measuring device (e. g. operation hours counter). The battery capacity is determined as follows: Discharging current (A) x discharging time (h) = battery capacity (Ah). The rest capacity determined such way shall at least be 80 % of the nominal capacity C_{Nenn} .

5.11 Deep discharge

5.11.1 Test conditions

The test of deep discharge is made at an ambient temperature of (20 ± 5) °C on two batteries. The actual capacity C_T of each battery as determined according to clause 5.6 shall be ≥ 100 % of the nominal capacity C_{Nenn} .

Remark: The average temperature during the test shall be as close as possible to 20 °C.

5.11.2 Test setup

A load-resistance is connected to the terminals of each battery after a charging time of 48 h (conditions as described in clause 5.6.2). The resistance value has to be chosen in a way that a discharging current of $I_{10} \pm 10$ % is flowing at a cell voltage of 2 V/cell. In this state the battery is stored for 30 days at conditions as described in clause 5.9.1.

5.11.3 Following charging

Immediately after the deep discharge of 30 days the battery is recharged for 48 h (conditions as described in clause 5.6.2).

5.11.4 Discharge

After a break of 2 hours the capacity will be ascertained with a discharge current of I_{20} . The current value will be held constant during the whole discharge time at $\pm 1\%$. The discharge process will be finalized when the specified final voltage (cut-off voltage) of typically 1.75 V/cell has been reached.

5.11.5 Determination of capacity

The discharging time is registered with a time measuring device (e. g. operation hours counter). The battery capacity is determined as follows: Discharging current (A) x discharging time (h) = battery capacity (Ah). The actual capacity determined in such way shall at least be 95 % of the nominal capacity C_{Nenn} .

5.12 Long term behaviour

5.12.1 Test conditions

The test of the long term behaviour (charging maintenance operation) is made on two batteries at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$ for a period of four years. The actual capacity C_T of each battery as determined according to clause 5.6 shall be 100 % of the nominal capacity C_{Nenn} .

Remark: The average temperature during the test shall be as close as possible to $20 ^\circ\text{C}$.

5.12.2 Charging maintenance operation

The batteries will be constantly charged after a 48-hour-charge (conditions as described in clause 5.6.2) with an end-of-charge current - corresponding to the ambient temperature - of $(2.3 \pm 0,01)$ V/cell at a reference temperature of $20 ^\circ\text{C}$. The current necessary for keeping the charging maintenance may be limited (e. g. to the maximum necessary charging maintenance current of 10 mA per Ah of the nominal capacity).

5.12.3 Annual measurement of the capacity

The capacity is tested annually with a discharge current of I_{20} . The current value will be held constant during the discharge with an accuracy of $\pm 1\%$. The discharge procedure is interrupted when reaching the end-of-charge voltage of 1.75 V/cell.

The batteries then are recharged for 48 h (conditions as described in clause 5.6.2) and set in charging maintenance operation.

5.12.4 Determination of the capacity

The discharge time is determined with a time measuring device (e. g. operation hours counter). The capacity of the battery is determined as follows: Discharge current (A) x discharge time (h) = capacity of the battery (Ah). The rest capacity determined such way shall at least be 80 % of the nominal capacity C_{Nenn} after 4 years.

Changes

Compared with edition VdS 2102 : 1984-01 (01) the following changes have been made:

- Addition of clause 2 (new) "Normative references"
- Addition of clause 3 (new) "Terms and definitions"
- Amendment of clause 4.4 „Marking“ by unambiguous requirements for labelling of VdS-approved batteries
- Addition of clauses 5.1.1 „Environmental conditions for tests“ and 5.1.4 „Documentation“
- Addition of clause 5.2 „Test matrix“
- Revision of clauses 5.3 to 5.12 in respect of testing
- Editorial changes

Annex A (informative)

Test scheme



