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Lead-acid starter batteries –

Part 1: General requirements and methods of test

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LEAD-ACID STARTER BATTERIES –

Part 1: General requirements and methods of test

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60095-1 has been prepared by IEC technical committee 21: Secondary cells and batteries.

This sixth edition cancels and replaces the fifth edition, published in 1988, amendment 1 (1993) and amendment 2 (1995).

This sixth edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
21/518/FDIS	21/525/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A and B form an integral part of this standard.

IEC 60095 consists of the following parts, under the general title *Lead-acid starter batteries:*

- Part 1: General requirements and methods of test
- Part 2: Dimensions of batteries and dimensions and marking of terminals
- Part 4: Dimensions of batteries for heavy trucks

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

LEAD-ACID STARTER BATTERIES –

Part 1: General requirements and methods of test

1 General

1.1 Scope and object

This part of IEC 60095 is applicable to lead-acid batteries with a nominal voltage of 12 V, used primarily as a power source for the starting and igniting of internal combustion engines, lighting and for auxiliary equipment of internal combustion engine vehicles. These batteries are commonly called "starter batteries".

This standard is not applicable to batteries for other purposes, such as the starting of railcar internal combustion engines.

The object of this standard is to specify

- general requirements;
- essential functional characteristics, relevant test methods and results required;

for several classes of starter batteries

- according to the general type of application,
- according to the climates in which they are predominantly operated,
- according to the type of product.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60095. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60095 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(486):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 486: Secondary cells and batteries*

IEC 60095-2:1984, *Lead-acid starter batteries – Part 2: Dimensions of batteries and dimensions and marking of terminals*

1.3 Definitions

For the purpose of this International Standard, the definitions of IEC 60050(486) are applicable.

2 Classification and designation of starter batteries

2.1 According to their application, three classes of batteries are defined as follows:

- Class A: corresponds in particular to passenger vehicles, light commercial vehicles and similar applications.
- Class B: corresponds in particular to trucks, buses, taxis, agricultural vehicles, machinery used for public works and similar applications.
- Class C: corresponds in particular to high temperature duty for passenger vehicles, light commercial vehicles and similar applications.

NOTE Characteristics related to class C batteries are under consideration.

2.2 According to their type:

- Vented (flooded) battery: a vented battery is a secondary battery having a cover provided with one or more openings through which gaseous products may escape.
- Valve-regulated (with gas recombination) battery: a valve-regulated battery is a secondary battery which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The battery cannot normally receive an addition of electrolyte.

In this type of battery, the electrolyte is immobilized.

2.3 According to the climate they are designed for:

Batteries of classes A and B are intended for use in temperate and cold climates. In these batteries, when fully-charged, the density of the electrolyte shall be

$$(1{,}28\,^{+0{,}02}_{-0{,}01})\ \text{kg/l at } 25\ ^\circ\text{C}$$

This density requirement is not applicable to valve-regulated batteries.

Batteries intended for use in warm or tropical climates shall be designated by adding the letter T to the class-designations A and B (i.e. AT and BT). In these batteries, when fully-charged, the density of the electrolyte shall be

$$(1{,}23\,^{+0{,}02}_{-0{,}01})\ \text{kg/l at } 25\ ^\circ\text{C}$$

This density requirement is not applicable to valve-regulated batteries.

3 Condition on delivery

New vented batteries may be supplied either

- in a state ready for use, filled with the appropriate electrolyte to the maximum level. After an initial charge (according to 6.2.1 and 6.2.2), the electrolyte density shall correspond to the relevant figures of 2.3;
- in a dry-and-charged (or charge-conserved) state not filled with electrolyte. The density of the acid to fill these batteries before use (unless otherwise recommended by the manufacturer) shall be

  1,28 kg/l ± 0,01 kg/l at 25 °C for class A and B, and

  1,23 kg/l ± 0,01 kg/l at 25 °C for class AT and BT.

Valve-regulated batteries are normally supplied in a state ready for use. For these batteries, the electrolyte is not accessible and, therefore, its density cannot be checked.

4 General requirements

4.1 Identification, labelling

Batteries according to this standard shall bear the following characteristics on at least the top or one of their four sides in indelible print:

4.1.1 Class of battery: (IEC) A or B or AT or BT (see 2.3).

4.1.2 Nominal voltage: 12 V

4.1.3 Capacity:

- either nominal capacity C_n (Ah), or
- reserve capacity C_r (min).

The values C_n or C_r for all classes of batteries according to 4.1.1 shall correspond to the electrolyte density given in 2.3.

4.1.4 Nominal cranking current: I_s (see 5.1.1)

4.1.5 Safety labelling

Batteries shall be marked with the six coloured symbols as described in B.1. However, to be in compliance with some national regulations, additional wording or special labelling can be used (for example safety label for North America area shown in B.2).

4.1.6 Valve-regulated batteries shall bear a special indication.

4.2 Marking of the polarity

According to clause 14 of IEC 60095-2, at least the positive terminal shall be identified by a "+" mark on the lid or on the terminal itself.

4.3 Additional designation

Vented starter batteries may be designated as "Low waterloss according to IEC 60095-1" or by suitable abbreviation if they comply with the requirements of 7.9 and the elevated requirement in 7.5.3.

NOTE Starter batteries are subject to a wide variety of operating conditions, for example temperature, overcharge voltage, etc., that have an influence on the decomposition of water from the electrolyte, regardless of internal design features. Thus, the term "low waterloss" in the sense of this standard is linked to well-defined conditions in 7.9 which do not cover the complete range of practical operating conditions.

4.4 Fastening of the battery

Where batteries are fastened to the vehicle by means of integral parts (for example bottom ledges), these shall be designed to withstand operating conditions as specified by national standards, by legal requirements or by vehicle manufacturers.

5 Functional characteristics

5.1 Electrical characteristics

5.1.1 *The cranking performance* is the discharge current I_s, as indicated by the manufacturer, which a battery can supply at –18 °C for class A and B, at 0 °C for class AT and BT for 60 s to a minimum voltage U_f = 8,40 V.

5.1.2 The *capacity* of a starter battery is defined for a temperature of 25 °C ± 2 °C.

It may be indicated by the manufacturer as either

- nominal capacity C_n or,
- nominal reserve capacity $C_{r,n}$.

The nominal capacity C_n is the electric charge in ampere hours (Ah) which a battery can supply with a current

$$I_n = \frac{C_n}{20} \quad \text{(A)}$$

until the terminal voltage falls to U_f = 10,50 V.

The effective capacity C_e shall be determined by discharging a battery with constant current I_n to U_f = 10,50 V to terminals (see 7.1). The resultant figure is used for the verification of C_n.

The nominal reserve capacity $C_{r,n}$ is the period of time (in minutes) for which a battery can maintain a discharge current of 25 A to a cut-off voltage U_f = 10,50 V.

The effective reserve capacity $C_{r,e}$ shall be determined by discharging a battery with the constant current I = 25 A to U_f = 10,50 V (see 7.2). The resultant discharge time, in minutes, is used for the verification of $C_{r,n}$.

NOTE For the correlation (relationship) of C_n and $C_{r,n}$, see annex A.

5.1.3 The *charge acceptance* is expressed as the ratio i_{ca}

- of the current I_{ca} which a partially discharged battery takes up at 0 °C and at constant voltage of 14,40 V, and
- of $I = C_e/20$

$$i_{ca} = \frac{I_{ca}}{C_e/20}$$

(see 7.4).

5.1.4 *Charge retention* is defined as the cold cranking performance of the charged and filled battery after storage on open circuit under defined conditions of temperature and time (see 7.5).

5.1.5 *Endurance in cycles* represents the ability of a battery to perform repeated discharge/recharge cycles and long rest periods on open circuit. This ability shall be tested by a series of cycles and rest periods under specified conditions after which the cold cranking performance shall be determined (see 7.6).

NOTE In the Eastern Asiatic and North-American regions, another test[1)] is in use to evaluate the endurance of batteries with discharge/charge cycles, the depth of discharge of which is less than specified here.

5.1.6 *Water consumption*: maintenance-free service of a battery requires a low rate of water decomposition through overcharge (see 7.9).

Valve regulated batteries have a very low water consumption and are not intended to receive additional water (see 7.9).

5.1.7 *Dry charged battery (or conserved charge battery)*: a new battery may be designated as dry charged (or conserved charge) if it can be activated ready for service just by filling it with the appropriate electrolyte and if it then conforms to the requirements of 7.12.

5.2 Mechanical characteristics

5.2.1 *Vibration resistance* represents the ability of a battery to maintain service under periodic or irregular acceleration forces. Minimum requirements shall be verified by a test (see 7.10).

5.2.2 *Electrolyte retention* is the ability of a battery to retain the electrolyte under specified mechanical conditions (see 7.11).

6 General test conditions

6.1 Sampling of batteries

All tests shall be carried out on new battery samples. Samples shall be considered as "new" not later than

- 30 days after shipment date of the manufacturer in the case of filled batteries;
- 60 days after shipment date of the manufacturer in the case of dry-charged or charge-conserved batteries.

1) i.e. SAE J240, July 1991.

6.2 Preparation of batteries prior to test – Definition of a fully-charged battery

All tests, except that in 7.12, shall commence with fully-charged batteries.

Vented batteries shall be considered as fully-charged if they have undergone one of the two charging procedures of 6.2.1 or 6.2.2 carried out at 25 °C ± 10 °C.

Valve regulated batteries shall be charged according to the procedure of 6.2.3 at 25 °C ± 10 °C (if necessary, an appropriate temperature control system shall be used, for example a water bath).

6.2.1 Charging of vented batteries at constant current

The battery shall be charged

- at a current of 2 I_n (see 5.1.2), until the voltage reaches 14,40 V, and
- then with the same current for a further 5 h.

In the case of recharging after a test for cranking performance (according to 7.3), the time shall be limited to 3 h instead of 5 h.

6.2.2 Charging of vented batteries at modified constant voltage

The battery shall be charged at a voltage of 16,00 V for 24 h with the maximum current limited to 5 I_n (see 5.1.2).

In the case of recharging after a test for cranking performance (according to 7.3) the charging time may be limited to 16 h.

NOTE If neither complete knowledge of the battery construction nor a specification from the manufacturer is available, then charging according to the present subclause is recommended.

6.2.3 Charging of valve regulated batteries

Unless otherwise recommended by the manufacturer, the battery shall be charged

- at a constant voltage of 14,40 V for 20 h with the maximum current limited to 5 I_n (see 5.1.2),
- then with a constant current of 0,5 I_n for 4 h.

6.3 Activation of dry-charged or charge-conserved batteries

Dry charged batteries shall be filled with the appropriate electrolyte (according to 2.3) to the maximum level indicated by internal or external marks of the battery or according to the manufacturer's instructions.

6.4 Measuring instruments

6.4.1 Electrical measuring instruments

The range of instruments used shall be appropriate for the magnitude of the voltage or current to be measured.

For analogue instruments, the readings shall be taken in the top third of the scale.

- Voltage measurement

  The instruments used for measuring voltages shall be voltmeters having an accuracy of class 1 or better. The resistance of the voltmeters shall be at least 300 Ω/V.

- Current measurement

  The instruments used for current measurement shall be ammeters having an accuracy class of 1 or better. The assembly of ammeter, shunt and leads shall have an overall accuracy of class 1 or better.

6.4.2 Temperature measurement

The thermometers used for measuring temperature shall have an appropriate range, and the value of each scale division shall not be greater than 1 K. The accuracy of the calibration of the instruments shall be not less than 0,5 K.

6.4.3 Density measurement

The density of the electrolyte shall be measured with hydrometers furnished with a graduated scale, the value of each division of which is equal at most to 0,005 kg/l. The accuracy of the instruments shall be to 0,005 kg/l or better.

6.4.4 Time measurement

The instruments used for measuring time shall be graduated in hours, minutes, seconds or in hours and centihours (ch) $\left(= \frac{1}{100} \text{h} \right)$. They shall have an accuracy of at least ±1 %.

6.5 Test sequence

6.5.1 Batteries filled and charged

a) Initially, the batteries are subjected to the following series of tests:
   - first C_e or $C_{r,e}$ check;
   - first cranking performance test;
   - second C_e or $C_{r,e}$ check;
   - second cranking performance test;
   - third C_e or $C_{r,e}$ check;
   - third cranking performance test.

   For both C_e or $C_{r,e}$ and the cranking performance, the specified values shall be met in at least one of the three relevant discharges above.

b) The tests according to table 1 shall be carried out only if batteries have complied with the previous tests, but not later than one week after completion of the first part.

Table 1 – Test / Battery

Test	Battery				
	1	2	3	4	5
Cyclic endurance (7.6)	X				
Charge retention (7.5)		X			
Charge acceptance (7.4)			X		
Electrolyte retention (7.11)			X		
Vibration resistance (7.10)				X	
Water consumption (7.9)					X
NOTE The test for water consumption should be applied only to vented "low waterloss" batteries according to 4.3 and to valve regulated batteries.					

6.5.2 Dry-charged or conserved-charge batteries

- initial cranking performance after filling with electrolyte (see 7.12)
- capacity test (see 7.1)

7 Tests/methods and requirements

7.1 Capacity check C_e

7.1.1 Throughout the duration of the tests, the battery shall be placed in a water bath at a temperature of 25 °C ± 2 °C. The terminal base of the battery shall be at least 15 mm but no more than 25 mm above the level of the water. If several batteries are in the same water bath then the distance between them and also the distance to the walls of the bath shall be at least 25 mm.

7.1.2 The battery shall be discharged with the current I_n (calculated according to 5.1.2) kept constant at ±2 % of the nominal value until the terminal voltage falls to 10,50 V ± 0,05 V. The duration t (h) of the discharge shall be recorded. The beginning of the discharge shall take place between 1 h to 5 h after the completion of charging according to 6.2.

7.1.3 The capacity C_e is as follows:

$$C_e = t \times I_n \quad \text{(Ah)}$$

7.2 Reserve capacity check $C_{r,e}$

7.2.1 The battery shall be placed in a water bath according to 7.1.1

7.2.2 One hour to 5 h after the end of charging according to 6.2, the battery shall be discharged with a current of 25 A ± 1 % until the terminal voltage has fallen to 10,50 V ± 0,05 V. The duration t (in minutes) of the discharge shall be recorded.

7.3 Cranking performance test

7.3.1 After a rest period of 1 h to 5 h after preparation according to 6.2.1, the battery shall be placed in a cooling chamber with (forced) air circulation at a temperature of –18 °C ± 1 °C for a minimum of 20 h or until the temperature in one of the middle cells has reached –18 °C ± 1 °C.

NOTE For batteries in classes AT or BT (see 2.3) the cranking performance should be tested at 0 °C.

7.3.2 The battery shall then be discharged, either within or outside the cooling chamber, within 2 min after the end of the cooling period with a current I_s (see 5.1.1). This current shall be kept constant to within ±0,5 % during the discharge.

7.3.3 After 60 s discharge, the terminal voltage shall be measured and shall be not less than 8,40 V.

7.4 Charge acceptance test

7.4.1 The battery shall be discharged at a temperature of 25 °C ± 2 °C at a current

$$I_0 = \frac{C_e}{10} \text{ for 5 h.}$$

The value C_e shall

- either be taken as the maximum value C_e of the three previous discharges according to 7.1,
- or be calculated from the maximum value $C_{r,e}$ of the three previous discharges according to 5.2 with the correlation formula shown in annex A.

7.4.2 Immediately after the discharge, the battery shall be cooled for 20 h to 25 h at 0 °C ± 1 °C.

7.4.3 At this temperature of 0 °C ± 1 °C, the battery shall be charged at a constant voltage of 14,40 V ± 0,10 V.

After 10 min, the charging current I_{ca} shall be recorded.

7.4.4 The ratio

$$i_{ca} = \frac{I_{ca}}{C_e/20} \text{ shall be } \geq 2.$$

7.5 Charge retention test

7.5.1 A fully-charged battery (according to 6.2), with its vent plugs firmly in place and a clean dry surface, shall be stored at 40 °C ± 2 °C on open circuit for a time (t) defined in 7.5.3. No connecting clamps or cables shall be attached to the terminals.

7.5.2 After this storage period, the battery shall be submitted, without recharge, to a cold cranking performance test according to 7.3.1 and 7.3.2. The voltage after 30 s of discharge shall be not less than 7,20 V.

7.5.3 Requirements

- Standard requirement for vented batteries: t = 21 days
- Elevated requirement for vented, low waterloss batteries and valve-regulated batteries: t = 49 days

7.6 Cyclic endurance test for batteries – Class A

7.6.1 Throughout the whole test period, with the exception of the rapid discharge test at the temperature –18 °C (see 7.6.5) the batteries are placed in a water bath at a temperature of 40 °C ± 2 °C. The terminal base of the battery shall be at least 15 mm but no more than 25 mm above the level of the water. If several batteries are in the same water bath, then the distance between them and also the distance to the walls of the bath shall be at least 25 mm.

7.6.2 The batteries shall be connected to a device where they undergo a continuous series of cycles, each cycle comprising

a) a discharge for 1 h at a current of $I = 5\ I_n$;

b) a recharge (immediately after the discharge) for 2 h at a constant voltage of 14,80 V ± 0,05 V (14,40 V ± 0,05 V for valve regulated batteries), the maximum current being limited to $I_{max} = 10\ I_n$.

7.6.3 After a series of 32 cycles of discharge and recharge, in accordance with 7.6.2, the batteries shall be disconnected from the endurance circuit and allowed to remain on open circuit for a period of 72 h. They shall be re-charged according to item b) of 7.6.2.

7.6.4 The whole sequence of 32 cycles, followed by the open-circuit period, constitutes one *endurance test unit.*

7.6.5 After three such units, the batteries are submitted to another series of 32 cycles and an open-circuit period of 72 h. The batteries are then, without re-charge, removed from the water bath, cooled to an electrolyte temperature of –18 °C ± 1 °C (measured in a central cell or for a minimum of 20 h) and discharged at the current I_s (see 5.1.1).

7.6.6 After 30 s of discharge, the voltage across the battery terminals shall be measured. It shall be not less than 7,20 V. The discharge shall then be terminated.

NOTE For batteries of class AT or BT, the final control of cranking performance at –18 °C should be replaced by a test at 0 °C with the current I_s.

7.7 Cyclic endurance test for batteries – Class B

7.7.1 The test shall be carried out on fully-charged batteries in accordance with 6.2.

7.7.2 Throughout the test period, with the exception of the discharge test at the temperature –18 °C (see 7.7.6 below), the batteries are placed in a water bath at a temperature of 40 °C ± 2 °C under the same conditions as in 7.6.1.

7.7.3 The batteries shall be connected to a device where they undergo a continuous series of cycles, each comprising

a) a charge for 5 h at a constant voltage of 14,80 V ± 0,05 V (14,40 V ± 0,05 V for valve regulated batteries) the maximum current being limited to $I_{max} = 5\ I_n \pm 2$ %, immediately followed by

b) a discharge for 2 h with a current 5 I_n.

7.7.4 At the end of the discharge of cycle no. 14, the final discharge voltage shall be not less than 10,0 V. After re-charging according to 7.7.3 a), the batteries shall be disconnected from the endurance test circuit and allowed to remain on open circuit for a period of 70 h.

7.7.5 The whole sequence of 14 cycles, followed by the open-circuit period, constitutes *one endurance test unit – Class B.*

7.7.6 Immediately after five such test units, the batteries shall, without recharge, be removed from the water bath, cooled to an electrolyte temperature of –18 °C ± 1 °C, (measured in a central cell) for at least 20 h and then discharged with the current I_s (in amperes).

After 30 s ± 1 s of discharge the voltage across the battery terminals shall be measured. It shall be not less than 7,20 V. The discharge shall then be terminated.

7.8 Cyclic endurance test for batteries – Class C

Under consideration.

7.9 Water consumption test

7.9.1 Vented batteries

7.9.1.1 The battery, after being charged according to 6.2, shall be cleaned, dried and weighed to an accuracy of ±0,05 %.

7.9.1.2 The battery shall be placed in a water bath maintained at a temperature of 40 °C ± 2 °C under the same conditions as in.7.6.1.

7.9.1.3 The battery shall be charged at a constant voltage of 14,40 V ± 0,05 V (measured across the battery terminals) for a period of 500 h.

7.9.1.4 Immediately after this overcharge period, the battery shall be weighed under the same conditions as in 7.9.1.1 with the same scales.

7.9.1.5 The loss in weight shall not exceed the value 6 g/Ah C_e (or 4 g/min $C_{r,e}$).

7.9.2 Valve regulated batteries

7.9.2.1 The battery is charged according to 6.2.

7.9.2.2 The battery shall be placed in a water bath maintained at a temperature of 40 °C ± 2 °C under the same conditions as in 7.6.1.

7.9.2.3 The battery shall be charged at a constant voltage of 14,40 V ± 0,05 V (measured across the battery terminals) for a period of 500 h.

7.9.2.4 Immediately after this first period the battery shall be cleaned, dried and weighed to an accuracy of ±0,05 % (weight W_1).

7.9.2.5 The battery shall be placed in a water bath maintained at a temperature of 40 °C ± 2 °C under the same conditions as in 7.6.1.

7.9.2.6 The battery shall be charged at a constant voltage of 14,40 V ± 0,05 V (measured across the battery terminals) for a period of 1 000 h.

7.9.2.7 Immediately after this overcharge period, the battery shall be weighed under the same conditions as in 7.9.2.4 with the same scales (weight W_2).

7.9.2.8 The loss in weight divided by 2: $[(W_1 - W_2)/2]$, shall not exceed the value 1 g/Ah C_e (or 0,67 g/min $C_{r,e}$).

7.9.2.9 Alternatively, the battery shall be submitted, without water addition, to a cold cranking performance test to the end voltage $U_f = 7{,}20$ V. The minimum duration of the discharge shall be specified in national requirements.

7.10 Vibration resistance test

7.10.1 After charging according to 6.2, the battery shall be stored for 24 h at a temperature of 25 °C ± 10 °C.

7.10.2 The battery shall be fastened rigidly to the table of the vibration tester. The fastening shall be of the same type as that used on a vehicle and secured by either

- the bottom hold-downs or ledges on the lower part of the container and suitable hold-down clamps and bolts with M8 thread, tightened to a torque of at least 15 Nm, or
- an angle-iron frame covering the upper edges of the battery case/cover assembly for a minimum width of X mm (see table 2), connected to the vibration table by four screwed rods with M8 thread, tightened to a torque of at least 8 Nm.

7.10.3 The battery shall be subjected for a period of T h (see table 2) to a vertical vibration of a frequency of 30 Hz to 35 Hz, these vibrations being as nearly sinusoidal as possible.

The maximum acceleration on the battery shall reach the value Z (see table 2).

7.10.4 After a maximum of 4 h from the end of the vibration, the battery shall be subjected, without recharge, to a discharge at a temperature of 25 °C ± 2 °C with a current I_s.

After 60 s discharge, the terminal voltage shall be measured. It shall be not less than 7,20 V.

Table 2 – Values for vibration resistance test

	Battery class	
	A, AT	B, BT
X	15 mm	33 mm
T	2 h	8 h
Z	30 ms^{-2}	50 ms^{-2}

7.11 Electrolyte retention test

7.11.1 Vented batteries

7.11.1.1 After charging according to 6.2, the battery shall be stored for 4 h on open circuit at a temperature of 25 °C ± 5 °C.

7.11.1.2 If necessary, the electrolyte level of each cell shall be adjusted to the maximum with purified water. The external surfaces of the battery shall be cleaned and dried.

7.11.1.3 The battery shall then be tilted in each direction at intervals of not less than 30 s between each tilting as follows:

a) the battery shall be tilted through 45° from the vertical in a maximum period of 1 s;

b) the battery shall be maintained in this position for 3 s;

c) the battery shall be returned to the vertical position in a maximum period of 1 s.

7.11.1.4 After this test, no evidence of liquid shall visible on the vent plugs.

7.11.2 Valve regulated batteries

7.11.2.1 The battery shall be charged according to 6.2.

7.11.2.2 Immediately after the end of charge, the battery shall be placed upside down on a sheet of blotting paper, put on a flat insulated surface, for 6 h at a temperature of 25 °C ± 5 °C.

7.11.2.3 After this test, no evidence of electrolyte shall be visible on the blotting paper.

7.12 Cranking performance for dry-charged (or conserved-charge) batteries after activation

7.12.1 The dry-charged battery and a sufficient amount of electrolyte supplied by, or according to the manufacturer's specifications, shall be stored at 25 °C ± 5 °C for at least 12 h (before filling).

7.12.2 The battery shall be filled with its electrolyte up to the level indicated by the manufacturer. After a rest period of 20 min at the same ambient temperature, the battery shall be discharged at a current I_s.

After 120 s, the terminal voltage shall be not less than 6,0 V.

Annex A
(normative)

Correlation between C_n and $C_{r,n}$

The value of $C_{r,n}$ (in minutes) may be estimated from C_n (in ampere hours) using the following equation:

$$C_{r,n} = \beta\,(C_n)^{\alpha}$$

where

α = 1 170 for flooded batteries, or 1,130 for valve regulated batteries;

β = 0,830 for flooded batteries, or 1,070 for valve regulated batteries.

Reciprocal equation:

$$C_n = \delta\,(C_{r,n})^{\gamma}$$

where

γ = 0,855 for flooded batteries and 0,885 for valve regulated batteries;

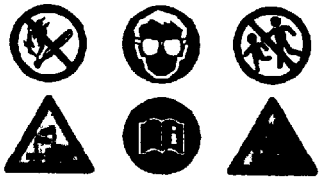
δ = 1,172 for flooded batteries, and 0,942 for valve regulated batteries.

Annex B
(normative)

Safety labelling

B.1 Definition of the six coloured symbols

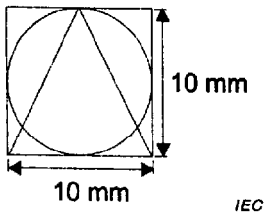
The symbols mentioned in 4.1.5 are shown in figure B.1:



IEC 2515/2000

Figure B.1 – Symbols for safety labelling

The symbols shall have common dimensions as shown in figure B.2 with a minimum dimension of 10 mm.



IEC 2516/2000

Figure B.2 – Dimensions for symbols in safety labelling

The symbols shall be located in a group on the top of the battery (as shown for example in figure B.1).

No text in any language shall be used with the symbols.

In the original equipment market, the meaning of the symbols shall be found in the vehicle manual in the appropriate language.

In the replacement market, the meaning of the symbols shall be in the booklet supplied with the battery which already contains information for warranty, precautions for handling, instructions for use, etc.

The meaning of the symbols are as follows:

(RED)	No smoking, no naked flames, no sparks
(BLUE)	Shield eyes
(RED)	Keep away from children
(YELLOW)	Battery acid
(BLUE)	Note operating instructions
(YELLOW)	Explosive gas

The meaning of the symbols are as follows:

(RED)	No smoking, no naked flames, no sparks
(BLUE)	Shield eyes
(RED)	Keep away from children
(YELLOW)	Battery acid
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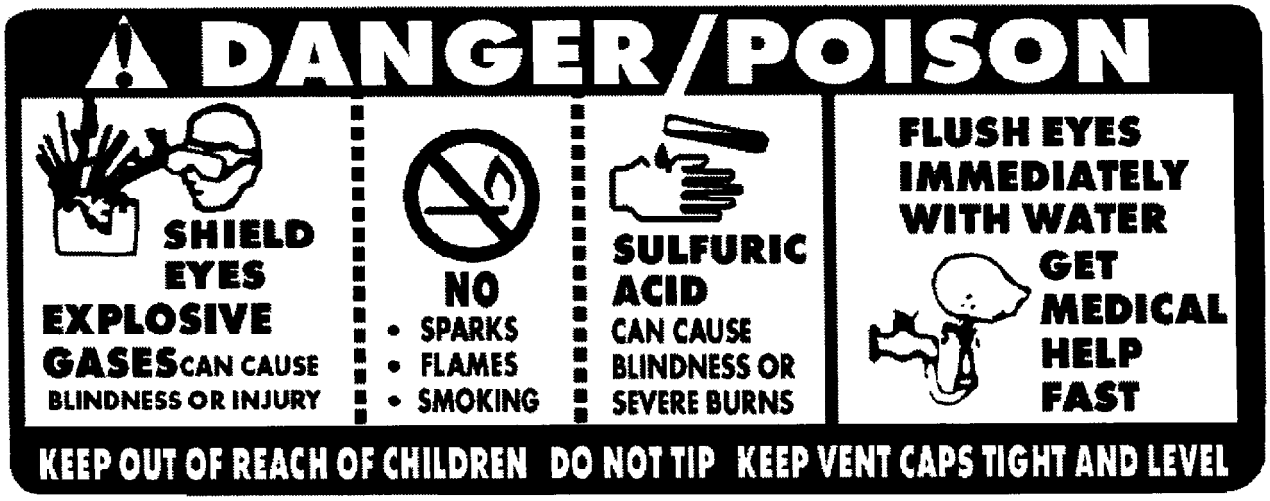
(YELLOW)	Explosive gas

B.2 Safety labelling – Label for North America area



IEC 2517/2000