BS EN 50342-1:2015

BSI Standards Publication

Lead-acid starter batteries

Part 1: General requirements and methods of test

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National foreword

This British Standard is the UK implementation of EN 50342-1:2015. It supersedes BS EN 50342-1:2006+A1:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/21, Secondary cells and batteries.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Lead-acid starter batteries - Part 1: General requirements and methods of test

Batteries d'accumulateurs de démarrage au plomb - Partie 1 : Prescriptions générales et méthodes d'essais

Blei-Akkumulatoren-Starterbatterien - Teil 1: Allgemeine Anforderungen und Prüfungen

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European foreword

This document (EN 50342-1:2015) has been prepared by CLC/TC 21X “Secondary cells and batteries”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-10-05
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2018-10-05

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 50342-1:2006.

EN 50342, *Lead-acid starter batteries*, is currently composed of the following parts:

− *Part 1: General requirements and methods of test* [the present document];

− *Part 2: Dimensions of batteries and marking of terminals*;

− *Part 3: Terminal system for batteries with 36 V nominal voltage*;

− *Part 4: Dimensions of batteries for heavy vehicles*;

− *Part 5: Properties of battery housings and handles*;

− *Part 6: Batteries for Micro-Cycle Applications* [currently at Formal Vote stage];

− *Part 7: General requirements and methods of tests for motorcycle batteries* [currently at Formal Vote stage].

EN 50342-1:2015 includes the following significant technical changes with respect to EN 50342-1:2006:

a) The following topics have been reworked/changed in the new version:

   1) simplified structure;

   2) correction of errors;

   3) updated to actual state of art of lead acid batteries;

   4) definition of new requirement levels and a new system for identification.

b) The following test procedures and requirements have been updated:

   1) charging procedure (reworked);

   2) cold cranking procedure (reworked);

3) charge retention (reworked);

4) deep discharge (new);

5) cycling (reworked);

6) water consumption;

7) vibration test procedures (reworked and new requirement level V4 added for heavy trucks).

1 Scope

This European Standard is applicable to lead-acid batteries with a nominal voltage of 12 V, used primarily as a power source for the starting of internal combustion engines, lighting and also for auxiliary equipment of internal combustion engine vehicles. These batteries are commonly called “starter batteries”. Batteries with a nominal voltage of 6 V are also included within the scope of this standard. All referenced voltages need to be divided by two for 6 V batteries.

This European Standard is applicable to batteries for the following purposes:

- batteries for passenger cars,
- batteries for commercial and industrial vehicles.

This European Standard is not applicable to batteries for other purposes, for example the starting of railcar internal combustion engines or for motorcycles.

2 Normative references

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

EN 50342–2, *Lead-acid starter batteries — Part 2: Dimensions of batteries and marking of terminals*

EN 50342–4, *Lead-acid starter batteries — Part 4: Dimensions of batteries for heavy vehicles*

EN 50342-5, *Lead-acid starter batteries — Part 5: Properties of battery housings and handles*

EN 50342–6, *Lead-acid starter batteries — Part 6: Batteries for Micro-Cycle Applications*

EN 61429, *Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135 and indications regarding directives 93/86/EEC and 91/157/EEC (IEC 61429)*

IEC 60050–482, *International Electrotechnical Vocabulary — Part 482: Primary and secondary cells and batteries*

3 General

3.1 Introduction

The object of this standard is to specify:

- general requirements;
- certain essential functional characteristics, the relevant test methods and results required, for several classes and types of starter batteries.

For general definitions of terms see IEC 60050-482, Part 482 of the International Electro-technical Vocabulary (IEV).

3.2 Designation of starter batteries

Batteries are classified according to their types.

3.2.1
flooded or vented batteries
secondary battery having a cover provided with one or more openings through which gaseous products may escape

3.2.2
Enhanced Flooded Batteries
EFB
secondary batteries with additional special design features to significantly improve the cycling capability compared to standard flooded batteries

Note 1 to entry: These batteries need to have a water consumption performance level of W3, W4 or W5.

3.2.3
Valve Regulated Lead-Acid batteries
VRLA
valve regulated lead-acid batteries are secondary batteries which are closed under normal conditions but which has an arrangement that allows the escape of gas if the internal pressure exceeds a predetermined value

Note 1 to entry: The battery cannot receive addition to the electrolyte. In VRLA batteries the electrolyte is immobilized.

3.2.4
Absorbent Glass Mat batteries
AGM
VRLA batteries in which the electrolyte is immobilized by absorption in a glass mat

3.2.5
gel batteries
VRLA batteries in which the electrolyte is immobilized by fixing as gel

3.3 Condition on delivery

3.3.1 Specific gravity of electrolyte and open circuit voltage

Specific gravity of electrolyte and open circuit voltage of a lead acid battery depend on its state of charge and temperature.

The specific gravity of the electrolyte of fully charged vented batteries shall be in the range 1,27 kg/l to 1,30 kg/l at 25 °C unless otherwise specified by the manufacturer.

The open circuit voltage (OCV), of fully charged batteries after a minimum of 24 h stand on open circuit, shall be in the range 12,70 V to 12,90 V for vented types and 12,80 V to 13,00 V for valve regulated types at 25 °C unless otherwise specified by the manufacturer.

3.3.2 Definition of fully charged new battery

New vented batteries may be supplied:

- either in a state ready for use, filled with the appropriate electrolyte to the maximum level. 24 h after an initial charge (according to 5.2), the specific gravity of electrolyte or OCV shall be within the ranges specified in 3.3.1. In batteries with lids without plugs checking specific gravity of electrolyte is generally not possible. In these cases, only OCV shall be checked according to 3.3.1;

- or dry charged as defined in Clause 7.

Valve regulated batteries are normally supplied in a state ready for use. After an initial charge according to 5.2 followed by a 24 h rest period, the OCV shall be within the range specified in 3.3.1. For these batteries, the electrolyte is not accessible and therefore its specific gravity cannot be checked.

3.4 Electrical characteristics

3.4.1 The *cranking current* I_{cc}, to be indicated by the manufacturer, is the discharge current which the battery can supply at –18°C for 10 s to a minimum voltage U_f = 7,50 V and meeting requirements of a simulated cranking profile according to 6.2. It is used as well to check the high current discharge performance according to 6.3.

3.4.2 The *capacity* of a starter battery is defined for the temperature of 25 °C ± 2 °C. The nominal capacity C_n in this standard is a C20. It shall be indicated by the manufacturer as nominal 20 h capacity C20 (Ah).

The nominal 20 h capacity C_n is the electric charge (in Ah) that a battery can supply with a current:

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

to a final voltage 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 (see 6.1).

3.4.3 The *charge acceptance* is expressed as the current I_{ca} which a partially discharged battery accepts at 0 °C and a constant voltage of 14,40 V (see 6.4).

3.4.4 *Charge retention* is measured by the high current discharge performance of the charged and filled battery after storage on open circuit under defined conditions of temperature and time (see 6.5).

3.4.5 The *Cycling test* represents the ability of a battery to perform repeated discharge / recharge cycles. This ability shall be tested by a series of cycles under specified conditions after which the cold cranking performance and the 20 h capacity shall be determined (see 6.6).

3.4.6 The *Corrosion test* checks the resistance of a battery against overcharging at increased temperatures (see 6.7)

3.4.7 The *Deep discharge* test represents the ability of battery to overcome an over discharge in a vehicle by small loads during parking for a long time (see 6.8)

3.4.8 *Water consumption* test checks if the battery can keep its performance under extended exposure to heat and overcharge conditions. It is measured as loss of weight during overcharge of a fully charged battery and is defined as g/Ah C_e (see 6.9).

3.5 Mechanical characteristics

3.5.1 *Vibration resistance* represents the ability of a battery to maintain service under acceleration forces. (see 6.10)

3.5.2 *Electrolyte retention* is the ability of a battery to retain electrolyte under specified mechanical conditions (see 6.11).

4 General requirements

4.1 Identification, labelling

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

a) the identification of manufacturer or supplier;

b) the nominal voltage, i.e. 12 V or 6 V;

c) nominal capacity C20 (Ah) (see 3.4.2),

The values of C20 for all batteries shall correspond to the specific gravity of electrolyte or OCV given in 3.3.1;

d) the nominal cranking current I_{cc} (see 3.4.1);

e) the six coloured symbols as specified in Annex A, Safety labelling;

f) the marking for the separate collection and recycling according to EN 61429;

g) valve regulated batteries shall be marked ‘VRLA'.

h) Date of production (this could be a part of more complex code too)

i) Requirement levels according to water consumption, charge retention, endurance and vibration as specified in Annex C

Batteries may be marked with other information such as the filling and charging date.

Label size: The capacity C20 (Ah) and the cold cranking current I_{cc} (A) shall be displayed on a separate label or as text on a combined label (e.g. together with additional information of the producer or type mark). The size of the label shall be at least 3 % of the largest side of the battery. The character size high should be at least 3 mm. The label shall be fixed on one of the four sides or on the lid. A multiple labelling is allowed.

For batteries for micro-cycle application: Specific identification according to EN 50342-6.

4.2 Marking of the polarity

This shall be in accordance with:

- EN 50342-2, *Lead-acid starter batteries — Part 2: Dimensions of batteries and marking of terminals*;

- EN 50342-4, *Lead-acid starter batteries — Part 4: Dimensions of batteries for heavy vehicles*.

5 General test conditions

5.1 Sampling of batteries

All tests shall be carried out on new battery samples. Samples shall be considered as new no later than:

- 30 d after the acid filling and formation date in the case of filled and charged batteries,

- 60 d after shipment date of the manufacturer in the case of dry-charged batteries.

Out of different production or sampling lots 7 batteries shall be selected for testing. Six of these batteries shall be used for the tests. In case of equipment failures or technical deviation, one battery can be replaced to repeat the complete sequence for this battery.

All tests shall be performed only if above conditions and conditions according to 3.3.2 are fulfilled.

5.2 Charging method - Definition of a fully-charged battery

All tests, except that in 7.3, shall commence with fully-charged batteries.

Batteries shall be considered as fully-charged if they have undergone the charging procedures. Prior to the first capacity test, the battery charge shall be limited to 16 h.

If not specified differently by the battery manufacturer, the batteries that will be tested according to this standard shall be charged according to Table 1.

Table 1 — Charging method

Battery Type	Voltage U_c	Current	Time	Battery temperature	Remarks
Flooded batteries having size according to EN 50342–2	16,00 V ± 0,05 V	5 I_n	24 h (16 h)[a]	15 °C to 35 °C	
Flooded batteries having size according to EN 50342–4	16,00 V ± 0,05 V	5 I_n	20 h (16 h)[a]	15 °C to 35 °C	Step 1
	no limitation	I_n	4 h (0 h)[a]	15 °C to 35 °C	Step 2
Valve regulated batteries	14,80 ± 0,05 V	5 I_n	24 h (16 h)[a]	15 °C to 35 °C	
[a] After cranking performance test and prior to first capacity check (Step 1 of present Table).					

All charges shall be performed with batteries in a water bath at 25 °C ± 2 °C according to 5.3.2.

NOTE Using the water bath, it is generally accepted that the battery temperature during the charge will be maintained in the required range.

5.3 Test equipment

5.3.1 Measuring instruments

The range of instruments used shall be appropriate for the magnitude of the parameters to be measured. The minimum accuracy of test equipment is given in Table 2.

Table 2 — Accuracy of test equipment

Parameter	Accuracy of test equipment
Current for cold cranking tests	0,5 %
Current for other tests	1 % full-scale with a minimum accuracy of ± 30 mA
Voltage	±0,04 V
Temperature	±1 K
Time	±10 ms
Specific gravity of electrolyte	≤ 0,005 kg/l
Weight of battery	±1 g below 30 kg ±5 g above 30 kg

The instruments used for measuring time shall be graduated in hours, minutes and seconds.

5.3.2 Water bath

If a test needs to be carried out in a water bath, the following conditions shall be fulfilled. The terminal base of the battery shall be at least 15 mm but not more than 25 mm above the water surface level. 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.

Minimum soak time for batteries in water bath is 4 h.

If not stated differently in the individual test description the tolerance for the temperature of the water bath is ± 2 °C.

It is recommended to cover the surface of the water with floating elements using testing temperatures of 40 °C or more. This improves the thermal isolation against air and avoids evaporation of water.

5.4 Test sequence

Filled and charged batteries shall be subjected to the following initial test series:

a) 1st C_e check,

b) 1st cranking performance test;

c) 2nd C_e check,

d) 2nd cranking performance test;

e) 3rd C_e check,

f) 3rd cranking performance test.

For C_e and the cranking performance the specified values shall be met in at least one of the relevant discharges above.

It is not necessary to complete the sequence if the specified values are achieved on the first or second test other than for batteries that will subsequently be tested for charge acceptance.

If, and only if, the initial capacity and cranking tests are successful, the batteries shall be tested in accordance with the remainder of the test sequence given in Table 3.

These tests shall commence not later than one week after completion of the initial tests.

Table 3 — Test sequence

Step	Battery	Reference	1	2	3	4	5	6
1	Initial charge prior to test	5.2	X	X	X	X	X	X
2	1st Capacity check C_e	6.1	X	X	X	X	X	X
3	1st cranking performance test	6.2	X	X	X	X	X	X
4	2nd Capacity check C_e	6.1	(X)	(X)	(X)	X	(X)	(X)
5	2nd cranking performance test	6.2	(X)	(X)	(X)	X	(X)	(X)
6	3rd Capacity check C_e	6.1	(X)	(X)	(X)	X	(X)	(X)
7	3rd cranking performance test	6.2	(X)	(X)	(X)	X	(X)	(X)
8	Endurance in cycle test	6.6	X					
9	Corrosion test	6.7		X				
10	High current discharge	6.3	X	X				
11	Capacity check C_e	6.1	X	X				
12	Charge retention	6.5			X			
13	High current discharge	6.3			X			
14	Deep discharge	6.8			X			
15	Capacity check C_e	6.1			X			
16	Cranking performance test	6.2			X			
17	10 cycles with 50 % DOD	6.6			X			
18	Charge acceptance	6.4				X		
19	Electrolyte retention	6.11				X		
20	Vibration resistance	6.10					X	
21	Water consumption	6.9						X
22	High current discharge	6.3						X
(X) denotes that this test needs to be carried out if the previous same test did not achieve the requirement level. One of the batteries 1 to 6 can be replaced by battery 7 for testing starting from step 1 in case of unexpected deviations below 90 % C_n or test equipment failures during test.								

6 Test methods and requirements

6.1 Capacity check C_e

6.1.1 Throughout the duration of the tests, the battery shall be placed in a water bath at 25 °C ± 2 °C according to 5.3.2

6.1.2 The battery shall be discharged with the current I_n (calculated according to 3.4.2) kept constant at ± 1 % of the nominal value until the terminal voltage falls to 10,50 V ± 0,05 V. The duration t (h) of this

discharge shall be recorded. The beginning of the discharge shall take place within a period of 1 h to 5 h from the time of the end of charging.

6.1.3 The capacity C_e is $C_e = t \times I_n$ (Ah).

From each single test sequence, the maximum value of all performed capacity tests is taken to calculate the mean value of the 20-h capacity over the six batteries as

$$\overline{C_e} = \frac{\sum_{i=1}^{6} C_{e_i}^{max}}{6}$$

The standard deviation is calculated for these data as:

$$S = \sqrt{\frac{\sum_{i=1}^{6} \left(C_{e_i} - \overline{C_e} \right)^2}{5}}$$

6.1.4 Requirements:

As a target, the mean value of the capacity should be equal to or greater than the labelled capacity C_n. Due to inevitable statistical deviations, the requirement for compliance of 20-h capacity shall fulfil the following condition:

$$\frac{\left(\overline{C_e} - S \right)}{C_n} \geq 0,95$$

6.2 Cranking performance test

6.2.1 After a rest period of 24 h up to 72 h after preparation according to 5.2, the battery shall be placed in a cooling chamber with (forced) air circulation at a temperature of −18 °C ± 1 °C until the temperature of the middle cells has reached −18 °C ± 1 °C.

It is generally accepted that the required temperature will be achieved after a minimum period of 24 h in the cooling chamber.

6.2.2 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_{cc} (see 3.4.1). This current shall be kept constant to within ± 0,5 % during the discharge.

6.2.3 After 10 s discharge, the terminal voltage U_f shall be recorded and the current shall be cut off. The voltage U_f shall be not less than 7,50 V for all the 6 tested battery individuals in at least one sequence.

Subclauses 6.2.1 to 6.2.3 comprise stage 1 of the cranking performance test.

6.2.4 After a rest period of 10 s ± 1 s, the test shall be continued in accordance with 6.2.5.

6.2.5 The battery shall then be discharged at 0,6 I_{cc}. The current shall be kept constant to within ± 0,5 % during the discharge. The discharge shall be terminated when the battery voltage reaches 6 V. The discharge time (t'_{6v}) at 0,6 I_{cc} to 6 V shall be recorded in seconds.

Subclause 6.2.5 comprises stage 2 of the test.

6.2.6 t_{6v} is defined as the duration of the second stage (t'_{6v}) plus the equivalent duration of the first stage discharge if run at 0,6 I_{cc}, i.e. it is given, in seconds, by the following equation:

$$t_{6v} = t'_{6v} + \frac{10\,\text{s}}{0,6} = t'_{6v} + 17\,\text{s}$$

6.2.7 Requirements:

The battery shall comply with the following requirement:

$t_{6v} \geq 90$ s

6.3 High current discharge test at low temperature

6.3.1 After a rest period of up to 72 h the battery shall be placed in a cooling chamber with (forced) air circulation at a temperature of −18 °C ± 1 °C until the temperature of the middle cells has reached −18 °C ± 1 °C.

It is generally accepted that the required temperature will be achieved after a minimum period of 24 h in the cooling chamber.

6.3.2 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 0,6 I_{cc}. This current shall be kept constant to within ± 0,5 % during the discharge.

6.3.3 After 30 s discharge, the terminal voltage U_{30s} shall be recorded and the current shall be cut off.

6.3.4 Requirements:

If not stated differently in the preceded test the voltage U_{30s} shall be not less than 7,20 V.

6.4 Charge acceptance test

6.4.1 The battery shall be discharged at a temperature of 25 °C ± 2 °C at a current I_0 (A) for 5 h where:

$$I_o = \frac{C_e}{10\,\text{h}}$$

The value C_e shall be taken as the maximum value C_e of the previous discharges according to 6.1.

6.4.2 Within 10 min after the discharge, the battery shall be placed in a cooling chamber with (forced) air circulation at a temperature of 0 °C ± 1 °C until the temperature of the middle cells is 0 °C ± 1 °C.

It is generally accepted that the required temperature will be achieved after a minimum period of 15 h in the cooling chamber.

6.4.3 At this temperature, the battery shall be charged at a constant voltage of 14,40 V ± 0,05 V and I_{max} = 50 A for batteries having sizes defined in EN 50342-2 and I_{max} = 100 A for batteries having sizes defined in EN 50342-4.

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

6.4.4 Requirements:

I_{ca} shall be ≥ 2 I_0

6.5 Charge retention test

6.5.1 A fully-charged battery (according to 5.2) with its vent plugs firmly in place and with clean and dry surfaces shall be stored in a dry atmosphere at 40 °C ± 2 °C for 21 d on open circuit. No connecting clamps or cables shall be attached to the terminals.

6.5.2 After this storage period the battery shall be submitted without recharge to a high current discharge test as defined in 6.3.

6.5.3 Requirements:

Table 4 — Requirements charge retention

Level	Requirement	Dedicated to batteries having:
C1	U_{30s} > 8 V	water consumption requirement W1
C2	U_{30s} > 8,5 V	water consumption requirements W2, W3, W4 and W5

6.6 Endurance in cycle test

6.6.1 The tests shall be carried out on fully charged batteries in accordance with 5.2.

Table 5 — Parameters cycle test

Battery size according to	Test temperature	Charging voltage U	Constant current I (6.6.5.3)	Charging ratio CR
EN 50342–2	+40 °C ± 2 °C	14,4 V for VRLA 15,6 V for flooded	I_n	1,08
EN 50342–4	+25 °C ± 2 °C	15,6 V	2,5 I_n	1,10

6.6.2 The battery shall be placed in a water bath as defined in 5.3.2 and maintained at a temperature as state in Table 5.

6.6.3 The charging voltage U and charging ratio CR stated in Table 5 shall be used if not otherwise specified by the manufacturer of the battery to be tested.

6.6.4 Only for batteries having water consumption requirement W1 purified water shall be added to the battery as necessary during the test to maintain the electrolyte level in accordance with the manufacturer's recommendations.

6.6.5 The batteries shall be connected to a test device where they undergo a series of cycles. Each cycle consists of:

6.6.5.1 Discharge the battery for 2 h with a constant current of I = 5 I_n. Cut off criterion for this test is the voltage during the discharge. If it drops below 10,5 V the test shall be terminated.

6.6.5.2 As first step recharge the battery for maximum 5 h with a constant voltage and a current limitation of 5 I_n. Record the recharged capacity C_{rch} (Ah) during the charging.

Once the charging ratio CR:

$$CR = \frac{2\,C_{rch}}{C_n}$$

reaches the specified value of Table 5 stop the charging.

6.6.5.3 If the charging ratio CR is lower than specified in Table 5 after completion of 6.6.5.2 continue to recharge the battery in a second step with a constant current as specified in Table 5 until the charging ratio CR reaches the required value or until the maximum duration of 1 h for this step is reached.

6.6.6 Perform steps 6.6.5.1 to 6.6.5.3 as long as the voltage during discharge is above the limit or until the number of cycles of the requirement level is reached as defined in Table 6.

6.6.7 The following high current discharge test according to step 10 of Table 3 shall be performed without any preceding recharge of the battery.

6.6.8 Requirements:

Table 6 — Endurance in cycle test - requirement levels

Requirement level	Number of cycles
E1	80
E2	150
E3	230
E4	360

The requirement for the capacity test (with preceding charging according to 5.2) according to step 11 of Table 3 is:

$C_e \geq 0{,}5\ C_{20}$

6.7 Corrosion test

6.7.1 The test shall be carried out on fully charged batteries in accordance with 5.2.

6.7.2 The battery shall be placed in a water bath as defined in 5.3.2 and maintained at a temperature of 60 °C ± 2 °C.

6.7.3 The battery, maintained at 60 °C ± 2 °C, shall be charged at a constant voltage of 14,00 V ± 0,10 V for a period of 13 d.

6.7.4 The battery shall be stored on open circuit, still at 60 °C ± 2 °C, for a period of 13 d.

6.7.5 The battery shall be cooled to ambient temperature. Water shall be added, if possible, to maintain electrolyte level in accordance with the manufacturer's recommendations.

6.7.6 The battery shall then be recharged in accordance with 5.2 for 6 h.

6.7.7 The battery shall be stored for a rest period of 20 h.

6.7.8 The battery shall be discharged with a current of 0,6 I_{cc} at 25 °C ± 2 °C for 30 s. The 30 s voltage shall be recorded. If it is less than 7,20 V, the test shall be terminated.

6.7.9 The sequence 6.7.1 to 6.7.8 constitutes one corrosion test unit.

6.7.10 The whole sequence 6.7.1 to 6.7.8 shall be repeated until the required number of test units is completed or the cut-off criterion in 6.7.8 is reached.

6.7.11 Requirements:

The required number of corrosion test units is four.

6.8 Deep discharge test

6.8.1 The tests shall be carried out on fully charged batteries in accordance with 5.2.

6.8.2 The whole test is performed at a temperature of +25 °C, with the exception of cold cranking test and final cycling.

6.8.3 Discharge the battery at constant current I_n until U < 10,5 V. Within maximum 48 h rest, continue the discharge using a light bulb according to Table 7 for 168 h ± 4 h (7 d).

Table 7 — Light bulb values

Battery size according to	**Light bulb**
EN 50342–2	10 W (R10W)
EN 50342–4	21 W (P21W)
NOTE Light bulb values: according to ECE 37.	

6.8.4 Disconnect the bulb and after maximum 24 h the battery shall be recharged for 24 h according to 5.2. During this recharge the voltage and the current can be recorded.

6.8.5 A rest period of 1 d minimum and 4 d maximum is performed.

6.8.6 The requirement for the capacity check (without any further charging) of step 15 of Table 3 is $C_e \geq 0{,}8\ C_{20}$.

6.8.7 The requirement for the cranking performance test (with preceding charging according to 5.2) of step 16 of Table 3 is $U_{10s} \geq 7{,}5$ V.

6.8.8 Then 10 cycles with 50 % DOD of step 17 of Table 3 shall be performed according to steps 6.6.5.1 to 6.6.5.3. The test temperature, charging voltage, current limitations and the charging factor shall be chosen according to Table 5.

6.8.9 Requirements:

The discharge voltage during the 10 cycles shall fulfil the requirement stated in 6.6.5.1.

6.9 Water consumption test

6.9.1 The battery, after being charged according to 5.2 shall be cleaned, dried and weighed, in grams, with an accuracy of ± 1 g for batteries below 30 kg and ± 5 g for batteries heavier than 30 kg. The initial weight shall be recorded as W_i (g)

6.9.2 The battery shall be placed in a water bath as defined in 5.3.2 and maintained at a temperature of +60 °C ± 2 °C.

6.9.3 The battery shall be charged at a constant voltage of 14,40 V ± 0,05 V (measured across the battery terminals) without adding water for a number of days as stated in the requirement Table 8

6.9.4 Immediately after this overcharge period, the battery shall be cleaned, dried and weighed under the same conditions as initial weighing and using the same scales. The weight at the end of test shall be recorded as W_e (g).

6.9.5 The weight loss WL (g / Ah C_e) is calculated as:

$$WL = \frac{W_i - W_e}{C_e^{max}}$$

6.9.6 24 h after taking the battery out the water bath, the high current discharge test according to 6.3 (step 22 of Table 3) shall be performed without any preceding recharge.

6.9.7 Requirements:

The weight loss shall not exceed the values stated in the requirements in Table 8.

Table 8 — Levels, test conditions and requirements

Requirement level	**Duration** days	**Weight Loss** g / (Ah C_e)
W1	21	< 24
W2	21	< 16
W3	42	< 8
W4	42	< 4
W5	84	< 4

6.10 Vibration resistance test

6.10.1 The fully charged battery according to 5.2 shall be immediately discharged at 0,6 I_{cc} at 25 °C ± 2 °C until the battery voltage reaches 6,0 V. The voltage at 60 s (U(60s)) and the time to 6 V (t_{6V}(bv)) shall be recorded.

6.10.2 Requirements:

U(60s) ≥ 7,5 V

6.10.3 After a recharge for 16 h according to 5.2 the battery shall be stored for at least 24 h at a temperature of 25 °C ± 5 °C.

6.10.4 The battery shall be fastened rigidly to the table of the vibration tester to prevent any movement. Passenger car batteries can be mounted using base hold downs if available or overhead mountings according to EN 50342-2. Truck batteries shall be mounted by overhead mounting according to EN 50342-4. Clamping forces shall be chosen to properly fix the battery but shall not exceed the maximum surface load according to EN 50342-5.

6.10.5 For vibration levels V1, V2 and V3 the battery shall be subjected for a period of T (h) to a vertical sinusoidal vibration at a constant frequency of 30 Hz ± 2 Hz and a constant acceleration as indicated in Table 9.

Table 9 — Vibration resistance - Levels V1 - V3

Parameter	Requirement level		
	V1	V2	V3
Period of vibration, T	2 h	2 h	20 h
Maximum acceleration on the battery, Z	30 ms^{-2}	60 ms^{-2}	60 ms^{-2}

6.10.6 For vibration level V4 the battery shall be subjected to a random noise profile in three orthogonal directions. The vibration loads are shown in Table 10. Testing time is 5h for each direction. The tests shall be performed consecutively in the order X, Y, and Z.

Table 10 — Vibration resistance - Level 4

	Acceleration spectral density (ASD) g^2 / Hz		
Frequency f Hz	**x-axis** (G_{rms} = 2,41)	**y-axis** (G_{rms} = 3,00)	**Z axis** (G_{rms} = 3,49)
5	0,005	0,05	0,05
10	0,05	0,3	0,5
15	0,2	0,3	0,5
20	0,2	0,3	0,5
50	0,06	0,08	0,05
100	0,005	0,01	0,01

The battery shall be orientated in such a way that the X direction is perpendicular and the Y direction is parallel to the surface of the electrodes inside the battery (example for A, B and C types according to EN 50342-4 is given in Figure 1)

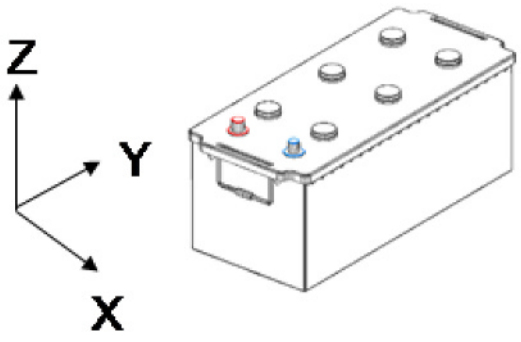

Figure 1 — Vibration directions

6.10.7 The temperature of the battery shall be maintained at 25 °C ± 5 °C during the vibration test.

If a detection of the point in time is needed when the first damage in battery occurs the following method should be used: Connect a suitable resistor to the battery that discharges the battery not more than 2 % of C_n

over 20 h and monitor the battery voltage. Any damages inside the battery will show a drop or a disruption in the signal of the measured voltage.

6.10.8 After a maximum of 5 d from the end of the vibration, the battery shall be discharged (without prior recharge) at a temperature of 25 °C ± 2 °C and a current of 0,6 I_{cc} until 6,0 V is reached. The voltage at 60 s (U(60s)) and the time to 6 V (t_{6V}(av)) shall be recorded.

6.10.9 Requirements:

U(60s) ≥ 7,2 V

t_{6V}(av) ≥ 0,8 t_{6V}(bv)

No acid spilling or visible mechanical damages may occur.

6.11 Electrolyte retention test

6.11.1 Vented batteries

6.11.1.1 A battery charged according to 5.2 shall be stored for 4 h on open circuit at a temperature of 25 °C ± 5 °C.

6.11.1.2 If possible, 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.

6.11.1.3 The battery shall then be tilted in each of the four directions:

a) the battery shall be tilted through 55° 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.

The pause between the different directions shall be between 30 s and 1 min.

6.11.1.4 Requirements:

After this test, no evidence of loss of liquid from the battery shall be visible.

6.11.2 Valve regulated batteries

6.11.2.1 The battery shall be charged according to 5.2

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

6.11.2.3 Requirements:

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

7 Dry-charged batteries

7.1 General

Vented flooded batteries may be supplied in a dry-charged state. Dry charged batteries can be activated by filling with the defined electrolyte to the maximum level indicated by internal or external marks or according to the manufacturer's activation instructions. After activation these batteries are ready to use.

Dry charged batteries are considered as new up to 60 d after shipment date of the manufacturer.

All requirements according to Clauses 3, 4, 5 and 6 of this standard are valid for dry charged batteries respectively.

The recommended maximum storage time, if not stated otherwise by the manufacturer, is 3 years.

7.2 Activation of dry charged batteries

The dry-charged battery and a sufficient amount of the electrolyte supplied, or according to the manufacturer's specifications, shall be stored at 25 °C ± 2 °C for at least 12 h (before filling).

After opening vent plugs each cell of the battery shall be filled with electrolyte at 25 °C ± 2 °C to the level indicated by the manufacturer by doing following steps:

- initial filling of the battery to the correct level
- soaking during at least 15 min, during which the battery may be slightly tilted several times
- adjustment of the acid level by addition of electrolyte
- cleaning of the plug holes with absorbent paper followed by mounting the plugs.

Any other additional instruction of manufacturer shall be respected also.

The specific gravity of electrolyte to fill dry charged batteries before use shall be in the range 1,27 kg/l to 1,30 kg/l at 25 °C unless otherwise specified by the manufacturer.

If an activated battery does not reach a minimum voltage of 12,60 V after 20 min, the battery should be recharged for 1 h with 16 V and I_{max} = 5 I_n.

7.3 Testing of dry charged batteries

7.3.1 Dry charged batteries shall be tested after activation without any charge concerning initial cranking performance.

7.3.2 After a rest period of 20 min at the ambient temperature of 25 °C ± 2 °C, the battery shall be discharged at a current 0,6 I_{cc} (see 3.4.1) according to 6.2.5 up to voltage of 6 V.

7.3.3 Requirements:

$t_{6v} \geq 90$ s

7.3.4 After this check and recharge according to 5.2 samples shall be tested following sequence defined in 5.4 with test specifications and requirements of Clause 6.

Annex A
(normative)

Safety labelling – Definition of the six coloured symbols

The symbols mentioned in 4.1 e) are shown in Figure A.1.

Figure A.1 — Coloured symbols

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

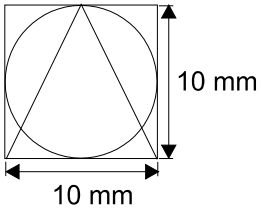

Figure A.2 — Symbol dimensions

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

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

In case of batteries that are supplied within new cars, the meaning of the symbols shall be found in the vehicle manual in the appropriate language.

In case of replacement batteries 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 meanings of the symbols are:

(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

Annex B
(normative)

Correlation between C20 and RC

The nominal reserve capacity RC is the time (in minutes) that a battery can maintain a discharge of 25 A to a cut-off voltage U_f = 10,50 V.

The value of RC (min) may be estimated from C20 (Ah) by the use of the following equation:

$$RC = \beta\,(\mathrm{C20})^{\alpha}$$

with:

	Flooded batteries	Valve regulated batteries
α =	1,182 8	1,120 1
β =	0,773 2	1,133 9

Reciprocal equation:

$$\mathrm{C20} = \delta\,(\mathrm{RC})^{\gamma}$$

with:

	Flooded batteries	Valve regulated batteries
γ =	0,845 5	0,892 8
δ =	1,242 9	0,893 9

Reserve capacity check RC:

The battery shall be placed in a water bath according to 5.3.2.

Within a 1 h to 5 h period after the end of charging according to 5.2, the battery shall be discharged with a current of 25 A ± 1 % until the terminal voltage falls to 10,50 V ± 0,05 V. The duration t (min) of the discharge shall be recorded.

The reserve capacity is $RC = t$ (min).

Annex C
(normative)

Battery performance marking

The battery performance level to be met shall be clearly stated on the battery, indicating:

W1 – W5:	Water consumption level according to 6.9
C1 – C2:	Charge retention level according to 6.5
V1 – V4:	Vibration level according to 6.10
E1 – E4:	Endurance level according to 6.6

The performance levels shall be given in this order only and the individual markings shall be separated by minus symbols. They should be shown together with the nominal voltage, the nominal C20 capacity and the nominal cranking current I_{cc}.

EXAMPLE

12V 80Ah 640A
EN 50342-1:W3-C2-V1-E1

Bibliography

[1] UN/ECE Regulation ECE37, *Agreement Concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions, Regulation No. 37: Uniform provisions concerning the approval of filament lamps for use in approved lamp units of power-driven vehicles and of their trailers*

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