British Standard

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BRITISH STANDARD

BS 6290-2:1999

Incorporating Corrigendum No. 1

Lead-acid stationary cells and batteries —

Part 2: Specification for the high-performance Planté positive type

ICS 29.220.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PEL/21, Secondary cells and batteries, upon which the following bodies were represented:

British Industrial Truck Association
British Telecommunications plc
Electricity Association
Electric Vehicle Association of Great Britain
Lighting Industry Federation Ltd.
Ministry of Defence
Society of British Battery Manufacturers
Society of Motor Manufacturers and Traders Ltd.
Co-opted members

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Contents

Foreword

This part of BS 6290 has been prepared by Technical Committee PEL/21.

This British Standard is part 2 of a series of standards. It specifies requirements for high-performance cells and batteries with Planté type positive plates and pasted negative plates. It supersedes BS 6290-2:1984 which is withdrawn.

BS 6290-1 has been withdrawn, having been superseded jointly by BS 6290-2:1999, BS 6290-3:1999, BS 6290-4:1997 and BS EN 60896-1:1992.

BS 6290-3 specifies requirements for lead-acid pasted positive plate type cells and batteries.

BS 6290-4 specifies the criteria for classifying lead-acid valve-regulated cells and batteries.

BS EN 60896-1 specifies general requirements for all free-venting types of stationary lead-acid cells and batteries.

Guidance on safety and health aspects of the handling, installation, usage and maintenance of lead-acid stationary cells and batteries is given in BS 6133.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 13 and a back cover.

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1 Scope

This part of BS 6290 specifies requirements for the materials, design and performance of stationary cells and batteries comprising individual lead-acid cells of the high-performance Planté positive type.

NOTE Information on applications is given in annex A. Annex B clarifies the position of these cells and batteries with respect to electromagnetic compatibility.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 3908-1, *Methods for the sampling and analysis of lead and lead alloys — Part 1: Sampling of ingot lead, lead alloy ingots, sheet, pipe and cable sheathing alloys.*

BS 3908-3, *Methods for the sampling and analysis of lead and lead alloys — Part 3: Bismuth in lead and lead alloys (photometric method).*

BS 3908-6, *Methods for the sampling and analysis of lead and lead alloys — Part 6: Tellurium in lead and lead alloys (photometric method).*

BS 3908-9, *Methods for the sampling and analysis of lead and lead alloys — Part 9: Sulphur in lead and lead alloys.*

BS 3908-15, *Methods for the sampling and analysis of lead and lead alloys — Part 15: Iron in lead and lead alloys (photometric method).*

BS 6133:1995, *Code of practice for safe operation of lead-acid stationary batteries.*

BS 6334:1983, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

BS EN 60896-1, *Stationary lead-acid batteries — General requirements and methods of test — Part 1: Vented types.*

3 Terms and definitions

For the purposes of this part of BS 6290, the terms and definitions given in BS 6133:1995, **1.3.2** apply, together with the following.

3.1

stationary cell

cell that is installed on a fixed site and is not intended to be moved continually during its life

3.2

stationary battery

two or more stationary cells electrically connected in series

3.3

lead-acid cell

cell in which the electrolyte is dilute sulfuric acid, and which is fitted with plates in which the active materials are:

a) positive electrode: lead dioxide;

b) negative electrode: spongy lead

3.4

free-venting enclosed cell

cell that is fitted with a vent plug which allows free venting of electrolysis gas

NOTE Provision is made for the addition of water and for measurement of the level and density of electrolyte. The cover is not intended to be readily removable.

3.5

high-performance Planté cell

free-venting enclosed cell containing Planté type positive plates and pasted negative plates

3.6

container

box in which plate groups and separators are assembled

3.7

group bar

bar to which a plate or group of plates is attached

3.8

vent plug

plug, provided with a gas vent or vents and baffled to arrest acid spray, that is fitted in the vent hole in the cover of an enclosed cell

NOTE A vent plug normally also provides access for filling.

3.9

length

dimension of a container or cell measured at right angles to the plates

3.10

width

horizontal dimension of a container or cell measured parallel to the plates

3.11

charging

passing of an electric current through a cell so as to bring it to a chemical condition in which it is capable of supplying electricity to an external circuit

NOTE The quantity of electricity passed is known as the charge and is usually measured in ampere hours.

3.12

float

operation of a cell or battery in parallel with a load and a charging source at constant voltage

3.13

discharge

taking out of a quantity of electricity from a cell by connecting it to an external circuit in such a way that the current flows through the cell in the reverse direction to that for charging

NOTE The quantity of electricity taken out is usually measured in ampere hours.

3.14

capacity

quantity of electricity that can be taken from a cell (or battery) at a particular rate of discharge, under specified conditions of voltage and temperature

NOTE Capacity is usually measured in ampere hours.

3.15

rated capacity

designation, by the manufacturer, of the capacity of a cell (or battery) under specified conditions of discharge

4 Materials and components

4.1 Positive plates

Positive plates shall be of the Planté lamelle type and shall be made of chemical lead conforming to Table 1. Sampling and chemical analysis of the lead shall be in accordance with relevant parts of BS 3908.

NOTE Analysis for impurities which are not covered by BS 3908 should be by documented instrumental methods.

The thickness and mass of the plates shall conform to Table 2.

4.2 Negative plates

Negative plates shall be of the open-grid type, pasted to sustain at least the capacity of the corresponding positive plate, as given in Table 2. The width and length of the negative plates shall not be less than those of their corresponding positives.

Intermediate negative plates shall have a capacity, at the C_{r3} rate (see **6.1**), at least 20 % greater than the rated capacity of their corresponding positives. The minimum thickness of the intermediate plates shall be as given in Table 2

4.3 Separators

Separators shall be made of a microporous material. They shall be designed to cover the facing surfaces of all the plates and to overlap the edges of the positive plates by no less than the dimensions given in Table 2.

4.4 Group bar

Group bars shall be made of pure lead or lead alloy. Where more than one pillar/group bar assembly is used in the assembly of the plate section, electrical continuity between group bars of like polarity shall be achieved by tack welding.

The current density at the 1 min discharge rate shall not exceed 1.5 A/mm^2 in any part of a group bar.

4.5 Terminal pillars

Terminal pillars or pillar/group bar assemblies shall be cast in lead alloy. They shall have a smooth surface finish, free from porosity and other defects, shall be compatible with the electrochemical conditions within the cell, and shall be suitable for mechanical connections.

If pillars contain copper inserts, this shall be stated by the manufacturer. If copper inserts are used, the covering of lead around the insert within the cell shall be at least 3.5 mm thick.

NOTE Pillars containing copper inserts are normally used in cells designed for high-discharge duties.

The current density at the 1 min discharge rate shall not exceed 2.5 A/mm^2 for lead pillars or 15.0 A/mm^2 for lead pillars with copper inserts.

The terminal pillars shall not carry any part of the weight of either plate group.

4.6 Containers

Containers shall be made of transparent material, e.g. styrene acrylonitrile.

The positive plates shall be hung from ledges moulded in the container. The negative plates shall be supported from the bottom of the container.

The weight of each plate group shall be transmitted vertically on to a flat base.

The clearance between the sides of the container and the positive plates, and between the bottom of the container and the positive plates, shall conform to Table 3.

4.7 Cell lids

Cell lids shall be sealed to the container. Terminal pillars shall be sealed where they pass through the lid

NOTE The sealing should be designed to prevent corrosion of the pillar above the lid.

Apart from the vent holes, the complete cell shall be sealed sufficiently to withstand an internal pressure of 1 961 Pa (200 mmH_2O).

4.8 Vent plugs

Vent plugs shall allow no visible wetting of the cell lid when the cell is being overcharged at the $0.09C_{r3}$ rate at 20 °C ambient temperature.

4.9 End springs or packing pieces

End springs or packing pieces shall be provided to hold the plate groups in position.

NOTE The end springs or packing pieces should be designed to hold the plate groups in position throughout the anticipated life of the cell.

5 Cell design

The number of plates per cell and the maximum external dimensions of the container shall be as given in Table 4.

6 Performance

NOTE Information on related cell capacities is given in annex C. Operational recommendations relating to performance are given in annex D. Information on recharge characteristics is given in annex E.

6.1 Capacity

6.1.1 The rated capacity shall be stated by the manufacturer in terms of a discharge time of 3 h, as detailed in BS EN 60896-1:1992, clause **6**, i.e. C_{r3}, at a fully charged electrolyte density of 1 207 kg/m^3 at 20 °C.

6.1.2 When the actual capacity of a cell is measured as a laboratory type test in accordance with BS EN 60896-1:1992, clause **13**, the cell shall achieve the rated value stated, C_{r3}, on the first discharge.

6.1.3 When the actual capacity of a battery is measured as a site test in accordance with BS EN 60896-1:1992, clause **13**, the battery shall achieve the rated value stated, C_{r3}, on the first discharge. No individual cell voltage shall be below 1.75 V after 2.5 h of discharge.

NOTE The voltage of individual cells of a battery may fall below 1.80 V (subject to the requirement of **6.1.3**). A cell whose voltage falls below 1.75 V after 2.5 h of discharge during site testing of a battery may be replaced and the test repeated.

6.1.4 If the capacity is also to be determined at the 1 h rate, the values shown in Table 5 shall be used. If additional tests for capacity are required at other discharge rates, the values of discharge current to the final voltages given in annex F shall be as stated by the manufacturer.

6.1.5 If the initial average temperature (see BS EN 60896-1:1992, **13.2** and **13.3**) is different from the reference temperature of 20 °C, the measured capacity C shall be corrected in accordance with **8.2**.

6.2 Endurance

When tested in accordance with BS EN 60896-1:1992, clause **15**, the endurance, in charge/discharge cycles, shall be that stated by the manufacturer.

6.3 Constant-voltage float-charge operation

When tested in accordance with BS EN 60896-1:1992, clause **14**, the cell or battery shall meet the requirements specified in BS EN 60896-1:1992, **7.2**.

6.4 Charge retention

When tested in accordance with BS EN 60896-1:1992, clause **16**, the charge retention shall be that stated by the manufacturer.

6.5 Short-circuit current and internal resistance

When tested in accordance with BS EN 60896-1:1992, clause **17**, the short-circuit current and internal resistance shall be as stated by the manufacturer.

6.6 Flammability of non-metallic parts

The flammability category of non-metallic parts in accordance with BS 6334:1983, **9.4** shall be stated by the manufacturer. When tested in accordance with method FV given in BS 6334:1983, the flammability category of the non-metallic parts shall be that stated by the manufacturer.

NOTE The principal non-metallic parts of a battery are the cell containers and lids. The flammability of the portion of the container in contact with electrolyte on its inner surface is reduced considerably by the thermal capacity of the electrolyte. As a consequence, the parts of the containers above the electrolyte level, together with the lid and accessories, are those most vulnerable to fire damage.

7 Type tests

Type tests shall employ the test sequences recommended in BS EN 60896-1:1992, clause **18**.

The accuracy of measuring instruments used in the tests shall conform to BS EN 60896-1:1992, clause **11**.

Cells and batteries shall be prepared for testing in accordance with BS EN 60896-1:1992, clause **12**.

8 General performance relationships

8.1 Discharge currents

A cell's discharge current, appropriate to its designation and to the discharge time and final voltage for which it is tested, shall be as given in Table 5.

8.2 Variation of capacity with temperature

Correction for the effect of temperature upon the capacity at a given rate of discharge (see Table 5) shall be made in accordance with Table 6 and the following equation:

$$C_a = \frac{C}{1 + \lambda(\vartheta - 20)}$$

where

C_a is the actual capacity in ampere hours (A·h) at the reference temperature of 20 °C;

C is the measured capacity in ampere hours (A·h) at the average temperature ϑ;

λ is the temperature coefficient of capacity variation per degree Celsius (°C) difference between the average temperature, ϑ, of the electrolyte, and the reference temperature of 20 °C, as indicated in Table 6;

ϑ is the average temperature in degrees Celsius (°C) during determination of the measured capacity.

9 Identification marks

Identification marks shall conform to BS EN 60896-1:1992, as amended by Amendment No. 1, clauses **19** to **22** (section six).

Table 1 — Maximum impurity levels for chemical lead

Impurity	Maximum impurity level %
Bismuth	0.030
Iron	0.001
Silver	0.005
Tellurium	0.000 5
Cadmium	None allowed
Sulfur	
Zinc	

Table 2 — Plates and separators

Positive plates			Intermediate negative plates	Minimum separator overlap	
Plate capacity A·h	Minimum thickness (before forming) mm	Minimum mass (without lugs, before forming) kg	Minimum thickness mm	Top/bottom mm	Side mm
6	7.1	0.45	3.8	7	3
20	7.4	1.39	3.8	10	3
80	9.5	5.90	4.7	19	6

Table 3 — Clearances between the container and plates

Positive plate capacity A·h	Minimum side clearance mm	Minimum bottom clearance mm
6	5	25
20	5	25
80	12	40

Table 4 — Number of plates per cell and maximum external dimensions of the container

Positive plate capacity	Number of positive plates per cell	Number of negative plates per cell	Maximum external dimensions of the container		
			Length	Width	Height
A·h			mm	mm	mm
6	2	3	77	134	223
6	4	5	115	134	223
6	6	7	191	134	223
6	8	9	191	134	223
6	10	11	229	134	223
20	3	4	135	204	350
20	4	5	135	204	350
20	5	6	173	204	350
20	6	7	173	204	350
20	7	8	210	204	350
20	8	9	210	204	350
20	9	10	248	204	350
20	10	11	248	204	350
20	11	12	287	204	350
20	12	13	287	204	350
20	13	14	363	204	350
20	14	15	363	204	350
20	15	16	363	204	350
20	16	17	363	204	350
20	17	18	363	204	350
20	18	19	363	204	350
80	5	6	257	368	592
80	6	7	257	368	592
80	7	8	307	368	592
80	8	9	307	368	592
80	9	10	307	368	592
80	10	11	357	368	592
80	11	12	357	368	592
80	12	13	433	368	592
80	13	14	433	368	592
80	14	15	433	368	592
80	15	16	509	368	592
80	16	17	509	368	592
80	17	18	509	368	592
80	18	19	585	368	592
80	19	20	585	368	592
80	20	21	585	368	592
80	21	22	585	368	592
80	22	23	585	368	592

Table 5 — Discharge currents (at an average cell temperature of 20 °C)

Cell designation		Discharge current A	
Positive plate capacity A·h	Number of positive plates per cell	Minimum discharge time and minimum final voltage per cell	
		1 h to 1.75 V	3 h to 1.80 V
6	2	9.0	4.0
6	4	18.0	8.0
6	6	27.0	12.0
6	8	36.0	16.0
6	10	45.0	20.0
20	3	45.0	20.0
20	4	60.0	26.7
20	5	75.0	33.3
20	6	90.0	40.0
20	7	105.0	46.7
20	8	120.0	53.3
20	9	135.0	60.0
20	10	150.0	66.7
20	11	165.0	73.3
20	12	180.0	80.0
20	13	195.0	86.7
20	14	210.0	93.3
20	15	225.0	100.0
20	16	240.0	107.0
20	17	255.0	113.0
20	18	270.0	120.0
80	5	300.0	133.0
80	6	300.0	160.0
80	7	420.0	187.0
80	8	480.0	213.0
80	9	540.0	240.0
80	10	600.0	267.0
80	11	660.0	293.0
80	12	720.0	320.0
80	13	780.0	347.0
80	14	840.0	373.0
80	15	900.0	400.0
80	16	960.0	427.0
80	17	1 020.0	453.0
80	18	1 080.0	480.0
80	19	1 140.0	507.0
80	20	1 200.0	533.0
80	21	1 260.0	560.0
80	22	1 320.0	587.0

Table 6 — Variation of capacity with temperature (10 °C to 35 °C)

Period of discharge	Temperature coefficient, λ, per degree Celsius deviation from 20 °C	
	Average temperature, ϑ, of the electrolyte	
h	10 °C to 20 °C	20 °C to 35 °C
3	0.009	0.007
1	0.010	0.009

Annexes

Annex A (informative)

Applications

Electrical performance characteristics determine the applications to which the high-performance Planté cell is most suited. The discharge characteristics do not vary throughout its life and the voltage characteristics on discharge, float or recharge are stable and reproducible.

Whilst there is no reliable test to confirm the service endurance of the product, experience has shown that, under well maintained float conditions, a product life of 20 years or more can be expected. Although the high-performance Planté cell can be cycled, its design is not appropriate to regular deep discharges.

The high-performance Planté cell is particularly recommended for power systems associated with telecommunications, switch operation, stand-by engine starting, uninterruptible power supplies and emergency lighting.

Annex B (informative)

Electromagnetic compatibility

Rechargeable cells or batteries within the scope of this standard are not sensitive to normal electromagnetic disturbances, and therefore no immunity tests are required under the terms of Directive 89/336/EEC (EMC Directive) [1].

Free-standing rechargeable cells or batteries electrically isolated from any associated electrical system are for all practical purposes electromagnetically inert, and therefore any requirement for conformity with Directive 89/336/EEC [1] in respect of electromagnetic emission is deemed to be satisfied.

It should be noted that the electrical system in which rechargeable cells or batteries are incorporated, or the manner in which they are used within that system, could fall within the scope of the Directive 89/336/EEC concerning electromagnetic compatibility. In such cases, the requirements of the Directive should be accommodated by the design of the system.

Further information on the application of CE marking in respect of the EMC Directive is given in CENELEC Report R021-001 [2] .

Annex C (informative)

Related cell capacities

The standard capacities of high-performance Planté cells at 20 °C and a discharge time of 3 h (C_{r3}), as defined in BS EN 60896-1:1992, clause **6**, can be derived by multiplying the number of positive plates per cell by the appropriate plate capacity. Examples are given in Table C.1.

The capacity, C_{r10}, of a cell at 15 °C and a discharge time of 10 h can be calculated by multiplying the capacity C_{r3} at 20 °C (in A·h) by a factor (F) of 1.25. Table C.1 gives examples.

Annex D (informative)

Operational recommendations

D.1 Rated capacity

Where the operating temperatures specified are outside the range 10 °C to 35 °C, the rated capacity C_{r3} at the specified operating temperatures should be declared by the manufacturer.

D.2 Service endurance

Arrangements for capacity tests to determine the end of useful service should be made. The manufacturer should be consulted to determine the frequency of the tests.

D.3 Conservation of charge

If a battery is likely to become isolated from its normal charging arrangements for a period of time, the manufacturer should be consulted concerning the procedures and timing for the charging needed to restore the battery to a healthy condition and to maintain that condition.

D.4 Maintenance

The manufacturer should indicate the frequency of the maintenance required during the operation of the battery. The maintenance interval, which can vary between 1 month and 18 months, is determined by the design of the cell, its age, mode of operation and charging methods.

Table C.1 — Examples of related cell capacities

Positive plate capacity, C_p A·h	**Number of positive plates per cell, n**	**Capacity at 3 h discharge rate at 20 °C, C_{r3}** ($C_p \times n$) A·h	**Factor, F**	**Capacity at 10 h discharge rate at 15 °C, C_{r10}** ($C_{r3} \times F$) A·h
6	10	60	1.25	75
20	18	360	1.25	450
80	20	1 600	1.25	2 000

D.5 Environmental conditions

The manufacturer should be consulted if a stationary battery is to be located where the temperature is outside the range 10 °C to 35 °C, or where the relative humidity exceeds 95 % for long periods.

D.6 Electrolyte and water

The electrolyte recommended by the manufacturer should be used. In the absence of any recommendation from the manufacturer, the sulfuric acid should conform to BS 3031:1996.

Topping-up water should be as recommended by the manufacturer. In the absence of any recommendations from the manufacturer, the water should conform to grade A specified in BS 4974:1975.

Annex E (informative)

Recharge characteristics

E.1 Trickle charging

The cell or battery is maintained in a fully charged condition indefinitely by the passage of a suitable constant current which compensates for the rate of self-discharge. Trickle charge rates are typically $0.4C_{r3}$ mA to $1.3C_{r3}$ mA, depending on the size of the cell. Trickle charging does not recharge a discharged battery.

E.2 Float charging

A charging source at a constant potential of 2.25 V per cell is applied to the battery and load. The d.c. source has the ability to supply continuous and variable direct currents, while ensuring that the battery is fully charged.

E.3 Constant-current charging

At the normal finishing rate of $0.09C_{r3}$ (where C_{r3} is the rated capacity in amperes for a 3 h discharge time), a fully discharged cell (C_{r3}) would require a recharge duration of approximately 14 h (see Figure E.1, curve A). It is possible to recharge in a shorter period of time (10 h) by commencing the charge at the starting rate, i.e. $0.18C_{r3}$ A. In this case, the rate should be reduced to the finishing rate when the voltage has reached 2.3 V per cell (see Figure E.1, curve B), by which point gassing will have commenced.

E.4 Limited-voltage charging

The charger voltage is normally limited to 2.25 V per cell and the current output should be not less than the sum of any continuous loads plus the recommended finishing rate for the battery or cell, i.e. $0.09C_{r3}$ A. Under these circumstances, the voltage/current/time profiles are typically as shown in Figure E.2 for a cell or battery which has been fully discharged at the 3 h rate.

The float voltage is sufficient to maintain a cell or battery in a fully charged condition provided that short recharge times are not required. If short recharge times are required, boost charge facilities, within the voltage range 2.40 V per cell to 2.70 V per cell, are necessary.

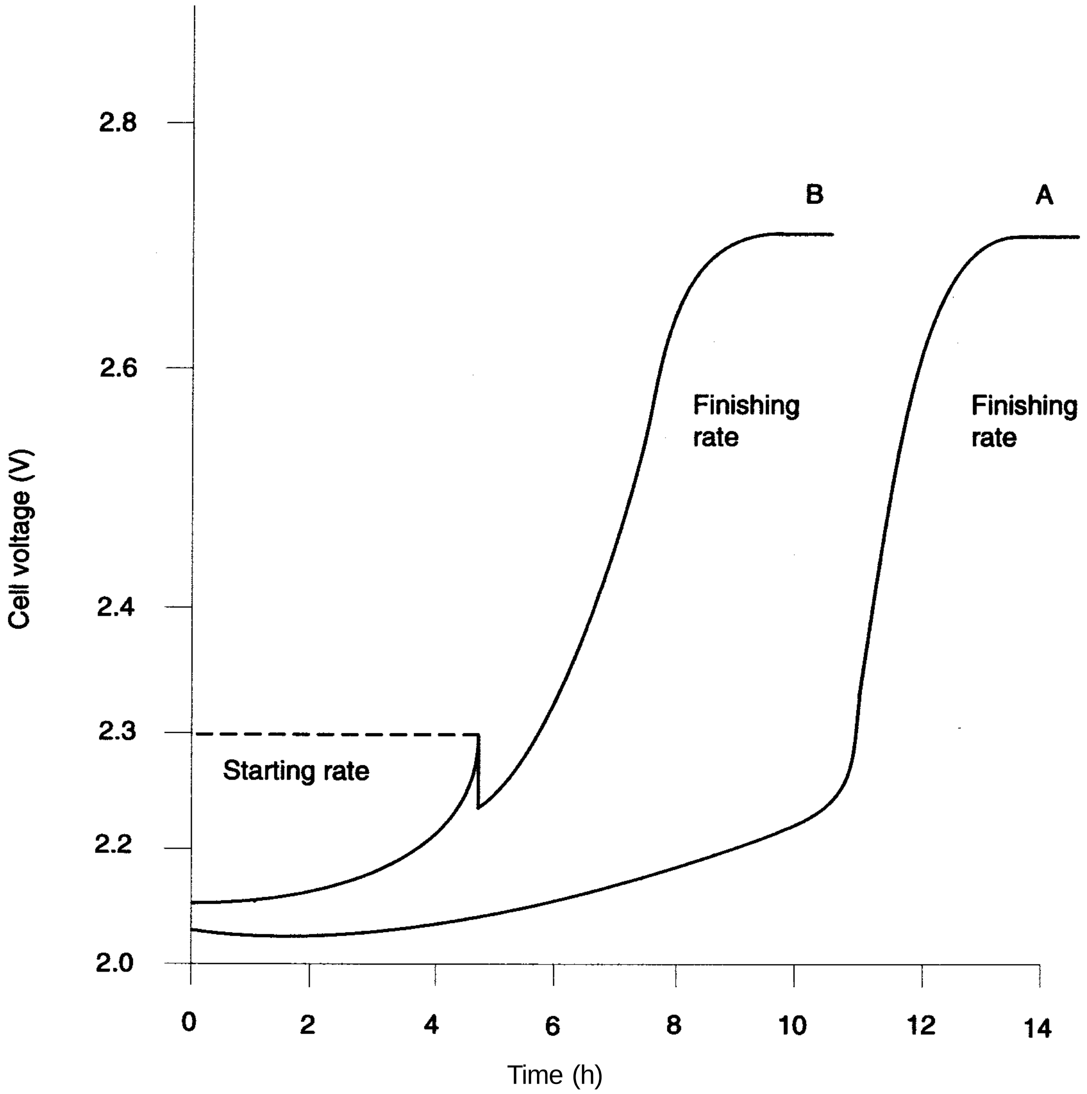

Figure E.1 — Typical recharge characteristics of high-performance Planté cells using constant-current charging following a discharge at the 3 h rate

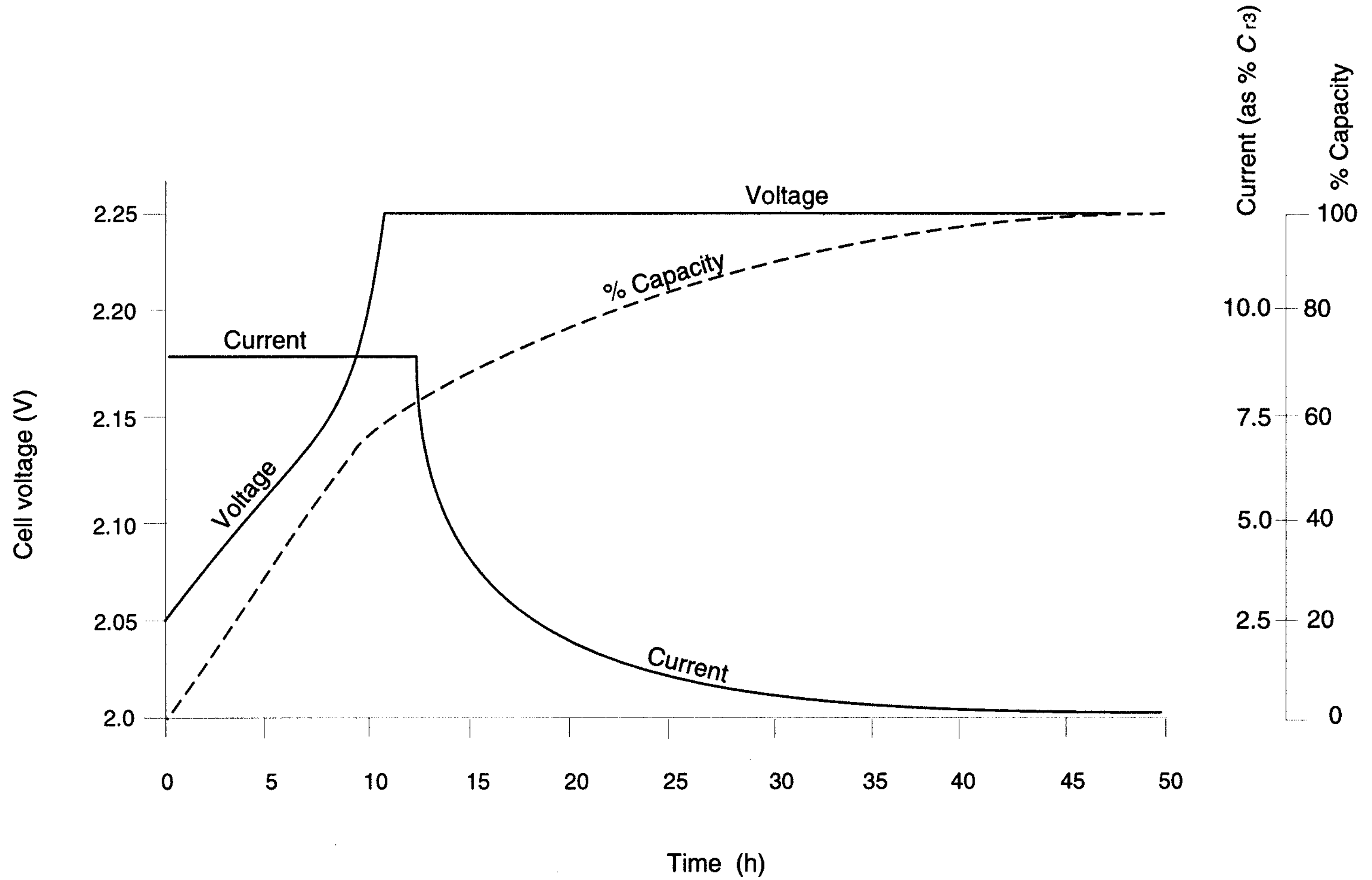

Figure E.2 — Typical recharge characteristics of high-performance Planté cells using limited-voltage charging following a discharge at the 3 h rate

Annex F (normative)

Additional capacity tests

If an additional test is required for capacity at a discharge rate between the 1 h and 10 h rates, the discharge shall be terminated at the appropriate final voltage given in Table F.1.

If an additional capacity test is required at a discharge rate faster than 1 h, the discharge shall be terminated at the appropriate final voltage given in Table F.2.

Table F.1 — Final voltages at discharge rates between 1 h and 10 h

Rate h	Final voltage per cell V
1	1.75
2	1.78
3	1.80
4	1.81
5	1.82
6	1.83
7	1.83
8	1.84
9	1.84
10	1.85

Table F.2 — Final voltages at discharge rates faster than 1 h

Rate min	Final voltage per cell V
1	1.60
5	1.62
15	1.65
30	1.69

Bibliography

Standards publications

BS 3031:1996, *Specification for sulfuric acid used in lead-acid batteries.*

BS 4974:1975, *Specification for water for lead-acid batteries*.

BS 6290-3:1999, *Lead-acid stationary cells and batteries — Part 3: Specification for the flat positive plate type.*

BS 6290-4:1997, *Lead-acid stationary cells and batteries — Part 4: Specification for classifying valve regulated types.*

Other publications

[1] EUROPEAN COMMUNITIES. 89/336/EEC. Council Directive of 3 May 1989 on the approximation of the Laws of the Member States relating to Electromagnetic Compatibility. (EMC Directive).

[2] CENELEC Report R021-001:1998, *Application of the CE marking requirements of secondary cells and batteries.*

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