

Lead-acid stationary cells and batteries —

Part 4: Specification for classifying valve regulated types

ICS 29.220.20

Committees responsible for this British Standard

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- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Industrial Truck Association
- British Railways Board
- British Telecommunications plc
- Electric Vehicle Association of Great Britain
- Electricity Association
- Health and Safety Executive
- Lighting Industry Federation Ltd.
- London Regional Transport
- Ministry of Defence
- Society of British Battery Manufacturers
- Society of Motor Manufacturers and Traders Ltd.

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Foreword

This British Standard has been prepared by Technical Committee PEL/21. It supersedes BS 6290-4:1987 which is withdrawn.

The start and finish of text introduced or altered by Amendment No. 1 is indicated in the text by tags **A1** **A1**.

BS 6290 was initially published in four parts. Part 1 specified the general requirements and methods of test and was a common reference to Parts 2, 3 and 4 which were product standards specifying the design and performance requirements respectively for Planté, flat plate and valve regulated lead-acid stationary cells and batteries.

The publication of BS EN 60896-1:1992 partially superseded BS 6290-1:1983 which was declared obsolescent. The relevant provisions of BS 6290-1:1983 which are not given in BS EN 60896-1:1992 are contained in this revision of BS 6290-4 and BS 6290-1:1983 is therefore withdrawn. Information on life at various temperatures, operational recommendations, general applications, acceptance tests and contractual information, have been transferred to Annex A of this standard.

The title of this revised standard has been changed to *Lead-acid stationary cells and batteries: Part 4. Specification for classifying valve regulated types*. This more accurately reflects the scope of the standard and will avoid confusion with Part 2 of BS EN 60896 which will carry a title similar to that of BS 6290-4:1987.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 29 and a back cover.

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1 Scope

This Part of BS 6290 specifies the criteria for classifying lead-acid units (cells or monoblocs) of the valve regulated type.

The system of classification relates to electrical performance, durability and safety. Information that can be used to estimate battery lives is shown.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 References

2.1 Normative references

This Part of BS 6290 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to, or revisions of, the cited publication apply to this Part of BS 6290 only when incorporated in the reference by updating or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Part of BS 6290 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 6290, the definitions given in BS 6133 apply, together with the following.

3.1

unit

a cell or monobloc

3.2

monobloc

a secondary battery in which the cells are fitted in a multi-compartment container

3.3

valve regulated cell

a secondary cell which is closed under normal conditions but which has a valve arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive addition to the electrolyte

3.4

thermal runaway

a critical condition arising during constant voltage charging in which the current and the temperature of the battery produce a cumulative, mutually reinforcing effect which further increases them, and which may lead to the destruction of the battery

4 Measuring instruments

4.1 Electrical measuring instruments

4.1.1 *Ranges of measuring devices*

The instruments used shall enable the values of voltage and current to be measured. The calibration of these instruments and the measuring methods shall be chosen so as to ensure the accuracy specified for each test.

NOTE 1 For analogue instruments this implies that readings should be taken in the last third of the graduated scale.

NOTE 2 Any other measuring instruments may be used provided they give an equivalent accuracy.

4.1.2 *Voltage measurement*

The instruments used for voltage measurement shall be voltmeters of an accuracy class equal to 0.5 or better. The resistance of the voltmeter used shall be at least 1 000 Ω/V (see BS 89-2).

4.1.3 Current measurement

The instruments used for current measurement shall be ammeters of an accuracy class equal to 0.5 or better. The entire assembly of ammeter, shunt and leads shall be of an accuracy class 0.5 or better.

4.2 Temperature measurement

For measuring temperature, thermometers shall be used having a suitable measuring range in which the value of each graduated division does not exceed 1 °C. The absolute accuracy of the instruments shall be ± 0.5 °C or better.

4.3 Time measurement

For measurement of time, the instrument accuracy shall be ± 1 % or better.

4.4 Gas pressure measurement

For measurement of pressure, the instrument accuracy shall be ± 1 % or better.

4.5 Gas volume measurement

For measurement of volume, the instrument accuracy shall be ± 1 % of full scale or better.

5 Capacity

5.1 Cell or unit capacity

5.1.1 The rated capacity C_{rt} (in A·h) is a reference figure, stated by the manufacturer, which is valid for a new unit, at a reference temperature of 20 °C, which has a discharge time of t hours to the final voltage U_f .

NOTE 1 Recommended values of t (in h) are $t = 20, 10, 8, 5, 3, 2, 1, 0.5, 0.25$. Of those various C_{rt} values, one value may be selected and declared as the nominal capacity C_{nom} . The most commonly used rated values of t (in h) are between 10 and 1, and the final discharge voltage U_f may be obtained from **B.3**.

5.1.2 For the purposes of this standard the rated values shall be $t = 3$; $U_f = 1.80$ V per cell, $C_{rt} = C_3$, and $I_{rt} = I_3$.

5.1.3 The discharge current I_{rt} (in A) that will flow from a unit of rated capacity C_{rt} (in A·h) at a temperature of 20 °C for a time t (in h) to a final voltage U_f (in V) is given by:

$$I_{rt} = \frac{C_{rt}}{t}$$

5.1.4 The actual capacity C_a shall be determined by discharging a fully charged unit in accordance with the test specified in **B.1**.

5.2 Verification of battery capacity

5.2.1 General

Battery capacity shall either be verified by consulting Table 1, which gives expected battery performance, supported by Table 3 and Table 4 which give unit performance and classification, or by performing a site test in accordance with **5.2.2**.

5.2.2 Battery acceptance by site test

If a site test is required, the test shall be conducted in accordance with **B.2**.

NOTE 1 The test in **B.2** may be used for alternative rates of discharge in which case the criteria specified in **B.3** apply.

The following requirements apply:

- a) the temperature corrected battery capacity, C_T , shall be greater than C_3 ; and
- b) the temperature corrected unit capacity shall meet the requirements for the appropriate performance class given in Table 4.

NOTE 2 In the case of marginal non-conforming units (i.e. where C_T meets the class performance less 2 %), a retest should always be considered as a precautionary measure against incomplete site charging.

NOTE 3 Table 1 can help the specifier to select the required performance stated in Table 2.

6 Safety features

6.1 Terminal pillars

The terminal pillars shall be cast in lead or lead alloy and $\overline{A_1}$ connect to $\overline{A_1}$ a threaded insert (male or female) to which mechanical connections can be made. The insert shall be prepared so that a sound electrical and mechanical bond is made with the pillar. The primary current path shall be between a flat surface on the pillar assembly and any connector and not via any threaded parts. The covering of lead $\overline{A_1}$, or other electrolyte impermeable material $\overline{A_1}$, round the insert within the unit shall be not less than 2 mm.

$\overline{A_1}$ Where the manufacturer has added an adaptor to the main female or male terminal as an extension of that terminal (e.g. front terminal adaptors), the adaptor shall sustain a 1 h rate constant current discharge for 1 h, and during this time the temperature rise of the adaptor shall not exceed 20 °C. The maximum current capability of such an adaptor shall be calculated and specified by the manufacturer. $\overline{A_1}$

6.2 Containers and lids

6.2.1 Flammability of containers, lids and covers

The containers, lids, and covers shall be made of flame retardant plastics materials. When tested in accordance with C.1, the materials shall be assigned to the category index rating stated in the test report (see C.1.3). The manufacturer shall state the level of rating (FV0, FV1, or FV2) achieved in the type test certificate.

$\overline{A_1}$ Note deleted. $\overline{A_1}$

6.2.2 Container integrity

The containers and lids shall be so designed as to minimize flexing of the surfaces under normal internal operating pressures, and operating temperatures up to 40 °C.

The lid shall be welded or bonded to the container, and the complete assembly, which includes the pillar to lid seal, shall be able to withstand without fracture for 5 h at 20 °C an internal pressure of five times the mean venting pressure declared by the manufacturer. The complete assembly shall be designed to be gas-tight and electrolyte-tight.

Table 1 — Performance class

Performance class (see Table 4)	Unit conformity %	Temperature corrected capacity performance (48 V battery) 3 h rate	
		Unit performance	Battery performance
1	99.9 % > C_3	All units $C_T > 0.99 C_3$	100 % batteries $C_T > C_3$
2	99 % > C_3	All units $C_T > 0.97 C_3$	100 % batteries $C_T > C_3$
3	99 % > C_3	All units $C_T > 0.95 C_3$	75 % batteries $C_T > C_3$
4	90 % > C_3	All units $C_T > 0.93 C_3$	0 % batteries $C_T > C_3$
The values for battery performance are based upon the 3 h rate of discharge and assume a battery size of 48 V. The battery performance for classes 3 and 4 will be different for larger battery sizes.			

6.3 Gas emission

The gas emission (G_E) in the overcharge float condition shall be measured by the gas emission test specified in C.2. The manufacturer shall state the gas emission value for new units in the type test certificate.

NOTE 1 The overcharge float condition is defined at 2.4 V per cell.

NOTE 2 The value of G_E may be used in Annex A of BS 6133 to calculate the ventilation requirements for racks, cabinets, and battery rooms. This can be achieved by converting the gas emission value G_E into an equivalent current I_E . The value of G_E has been referenced to an atmospheric pressure of 1 bar¹⁾ and an ambient temperature of 20 °C. To convert G_E into the equivalent current I_E the value of G_E has to be referenced to 0 °C. The equivalent current value I_E is given by the following formula.

$$I_E = \frac{G_E \times C_3 \times 273}{418 \times 293}$$

NOTE 3 The value of I_E is that equivalent current flowing through the battery at 2.4 V per cell and at 20 °C. If an estimate of the current flowing at higher temperatures is required, the value of I_E should be doubled for every 10 °C rise in temperature.

¹⁾ 1 bar = 10⁵ N/m² = 100 kPa.

6.4 High current endurance

6.4.1 Units claiming suitability for high current endurance shall be tested in accordance with **C.3** and shall satisfy the following requirements.

- a) During the test, the units shall show no indication of combustion and shall not explode as a result of self-ignition.
- b) The actual capacities of the units, C_a , after the high current test shall be not less than C_3 . The subsequent examination of the unit group bars and monobloc internal intercell connections shall show no sign of melting.

6.4.2 If the requirements of **6.4.1** are satisfied, the manufacturer shall state “H” (high current endurance) in the type test certificate. For those units not claiming suitability for high current endurance, the manufacturer shall state “L” (low current endurance) in the type test certificate.

NOTE 1 The test method in **C.3** indicates the safe operation of the battery and does not imply its longer term continued fitness for purpose.

7 Performance

NOTE This clause addresses product characteristics of an applications nature. It is not intended to state criteria to which the product should conform, but provides standardized test methods by which essential performance characteristics can be determined should they be required for the engineering or operation of battery systems.

Electromagnetic compatibility is addressed in Annex F.

7.1 Capacity conformity level

7.1.1 The manufacturer shall rate the capacity of the VRLA unit for periods of discharge between 5 min and 10 h. This may be achieved either by the capacity conformity level test specified in **D.1**, or by use of the manufacturer's own equivalent techniques.

7.1.2 The manufacturer shall calculate the level of conformity in accordance with **D.1.8**, at the following rates of discharge: 5 min; 15 min; 1 h; 3 h; 8 h and 10 h.

7.1.3 The manufacturer shall state the calculated levels of conformity in the type test certificate.

7.2 Cyclic endurance

Values for cyclic endurance shall be determined by the test method specified in **D.2**, and the manufacturer shall state the $\overline{A_1}$ minimum and maximum $\overline{A_1}$ cyclic endurance value in the type test certificate. A minimum of 50 cycles is required.

7.3 Charge retention

Values of the charge retained C_R , expressed as a percentage, shall be determined by the test method specified in **D.3** and the manufacturer shall state in the type test certificate the value of C_R achieved.

7.4 Internal resistance

Values of unit internal resistance (R_i) shall be determined by the test method specified in **D.4**.

The manufacturer shall state the internal resistance values of the unit in the type test certificate.

NOTE 1 This test method provides information on the d.c. resistance from stabilized test conditions, and does not indicate dynamic reactions, for example those occurring during the first milliseconds of a short circuit. The results of this test have an accuracy which is of the order $\pm 10\%$.

NOTE 2 For a.c. impedance values which may be required for converter applications, reference should be made to the battery manufacturer.

8 Durability

8.1 Life at elevated temperatures

A1 8.1.1 *Standard life test at the 8 h rate of discharge*

For the purposes of this standard, life shall be determined, at an elevated temperature of 55 °C, by the test specified in E.1. The manufacturer shall state the following in the type test certificate:

- a) the life in terms of the average endurance at the 8 h rate of discharge to 1.84 V per cell, and
- b) the float voltage at which the test was conducted.

For test certificate purposes this performance shall be presented as follows:

average endurance (in days) /rate of discharge (in h) /float voltage (in V).

Thus the performance of a product at the 8 h rate giving an average endurance of 330 days at a float voltage of 2.27 V per cell would be:

330/8/2.27.

NOTE 1 A conversion guide estimating lives at normal ambient temperatures is given in A.1.1.

NOTE 2 A method for estimating life at temperatures of between 20 °C and 40 °C is given in A.1.2. **A1** Text deleted **A1**

8.1.2 Additional, applications-dependent life tests at the 1 h and 0.25 h rates

For comparison purposes by either user or manufacturer and according to the demands for application, life tests at these additional rates shall be performed.

These tests shall be performed using the end voltages in Table B.1 and Table B.2 in accordance with the procedure in 8.1.1 and the test method specified in E.1. Note 1 and Note 2 of 8.1.1 do not apply. The resultant values for the average endurance shall be stated in 15a) and 15b) of the type test certificate shown in Table 3.

NOTE In order to save resources and testing time, laboratories may wish to perform all the discharge rates at the same time within one single programme. Whilst this is permitted within the test procedure, it is not recommended, as the consequences could be detrimental to the results obtained. **A1**

8.2 Float voltage characteristics

8.2.1 When testing in accordance with E.2, the manufacturer shall state in the type test certificate the value of float voltage, U_{flo} , used in the test.

8.2.2 The unit float voltage measurements, U_{1-6} , prior to the discharges 1, 3 and 4 shall be treated as one population. The maximum float voltage measurement, U_{MAX} , and the minimum float voltage measurement, U_{MIN} , shall be within the range ($U_{\text{flo}} \pm 3\%$).

If $U_{\text{MAX}} < (U_{\text{flo}} \pm 3\%) < U_{\text{MIN}}$, "PASS" shall be recorded in the type test certificate.

8.2.3 The unit capacities for day 8, day 91, and day 183 shall be plotted against the day number of the test, and the maximum unit reduction in capacity from the initial discharge, C_{IA} , to the final discharge, C_{FA} , shall be expressed as a % of C_{IA} in the type test certificate.

8.2.4 **A1** The unit capacities C_a following the second discharge on day 11, shall be greater than the rated capacity C_3 . If Day 11 $C_a > C_3$ for each unit, "PASS" shall be recorded in the type test certificate. **A1**

8.3 Pillar seal assembly

After testing in accordance with E.3, the manufacturer shall state in the test certificate which test was used, E.3.1 or E.3.2, and the number of days on test before the seals started to leak. This shall be taken as the number of days until the first recorded instance of a leaking seal in the sample tested.

8.4 Mechanical strength

Valve regulated stationary lead-acid units shall be designed to withstand the mechanical stresses met during normal transportation, handling, and climatic changes.

When tested in accordance with E.4, the **A1** three **A1** units shall remain gas and liquid tight, and in the 5 min rate discharge, performance of the three units subjected to the mechanical test shall be at least 90 % of the original value.

The manufacturer shall state in the type test certificate whether the units have passed or failed this test.

NOTE Resistance to earthquakes, shocks and vibration, if required, should be individually specified.

9 Classification

9.1 Type testing

NOTE Where cells and batteries employ the same materials, manufacturing process and plate/element design, as defined by the manufacturer's quality system, over a range of product sizes or product types, it is not necessary to test fully each individual design in the classification to obtain qualification, provided that manufacture is in the same factory.

9.1.1 Tests shall be undertaken according to the schedule given in Table 2.

9.1.2 Modifications to, or departures from, the tested design shall invalidate the qualification.

9.1.3 The manufacturer shall indicate the level of conformity of the product in the type test certificate.

NOTE The type test certificate is arranged into three groups of characteristics: safety, durability and performance. The format of the type test certificate is shown in Table 3.

9.2 Classification procedure

9.2.1 The classification of the product shall be established by reading the values in the status column of the type test certificate (Table 3) across to the corresponding row in the appropriate class column of the classification table (Table 4).

9.2.2 If in any one group of characteristics the product is represented in classes 1, 2 and 3, its overall classification shall be 3.

9.2.3 There is a requirement, irrespective of class, to indicate in the classification table whether the high current endurance test is applicable. To prevent misapplication of products, the status of the product in this respect shall be added to the classification (see Table 3 and 6.4.2).

9.2.4 The type test certificate and classification table shall be made available on request together with supporting test data.

Table 2 — Schedule of classification tests

Factor	Testing requirement	Clause reference
Flammability of containers lids and covers	Test the compounded materials	6.2.1
Container integrity	Test the assembly with the largest unsupported surface area	6.2.2
Internal resistance	Test each cell and battery	7.4
High current endurance	Test each cell and battery	6.4
Rated capacity/conformity level	Test the largest configuration of capacity and voltage within each product range (see note)	7.1
Pillar seal assembly	Test the largest configuration of capacity and voltage within each product range (see note)	8.3
Mechanical strength	Test the largest configuration of capacity and voltage within each product range (see note)	8.4
Life at elevated temperature	Test the largest configuration of capacity and voltage within each product range (see note)	8.1
Cyclic endurance	Test the largest configuration of capacity and voltage within each product range (see note)	7.2
Charge retention	Test the largest configuration of capacity and voltage within each product range (see note)	7.3
Float voltage characteristic	Test the largest configuration of capacity and voltage within each product range (see note)	8.2
Gas emission	Test the largest configuration of capacity and voltage within each product range (see note)	6.3
NOTE A product range is defined as those types using the same materials, manufacturing processes, quality systems and design of positive plates and negative plates, and elements. The largest configuration refers to: - the maximum outside dimensions; - the maximum capacity contained in one compartment; - the maximum voltage. If the largest dimensional configuration appears as either 2 × compartments (90 A·h each) at 4 V, or 3 × compartments (60 A·h each) at 6 V, the 4 V configuration is the preferred type for group qualification purposes.		