The British Power Conversion Company

Technical Information
British Standard 6290 Part 4

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British Standards 6290 Part 4, Section 3.1

Separators

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The separators shall be porous to electrolyte but electrically insulating. Sufficient separator overlap to the edges of the plates shall be provided to prevent short circuits forming between the edges of adjacent plates.

BPC specifications: **2 Volt bloc Gel & 6&12 Volt Monobloc Gel**

BPC Gel utilizes the best separator technology available in the world today; materials are manufactured in Germany under strict production control and test procedures. See following page for Gel separator specifications and characteristics.
Separator overlap is approximately 4mm at the sides and the top of the group to prevent the formation of shorts.

During production all dry batteries are short circuit tested and all finished batteries are High Rate tested.

BPC specifications: **2 Volt bloc AGM & 6&12 Volt Monobloc AGM**

BPC AGM utilizes a random woven glass mat to retain the electrolyte and prevent short circuits between the plates. Separator overlap is approximately 4 mm at the sides and the top. The “S” wrapping technique is utilized resulting in the bottom of every plate having a layer of separator to protect against shorting and mossing.

Quality characteristics

Electrical resistance

	Unit	Typical value	Test method
1. Separators with glassmat 04	Ω cm²	0.13	BS-TE-2002/2000
2. Separators with glassmat 06	Ω cm²	0.15	BS-TE-2002/2000
3. Separators with glassmat 08	Ω cm²	0.16	BS-TE-2002/2000

Physical and chemical properties

	Unit	Typical value	Test method
1. Wettability	s	3	BS-TE-2061
2. Acid weight loss	%	3	BS-TE-2063
3. Trace elements			
Iron	ppm	10	BS-TE-2075
Manganese	ppm	1	BS-TE-2075
Nickel	ppm	1	BS-TE-2075
Cobalt	ppm	1	BS-TE-2075
Copper	ppm	1	BS-TE-2075
Chloride	ppm	20	BS-TE-2076
4. Corner break	N	12	BS-TE-2080

Product description

DARAK® 2000 Industrial separators can be supplied in the following versions:

Positive ribs:

- ribs sloping at ca. 10°, called „diagonal ribs“ rib spacing:
  - typically 12 mm
- vertical ribs: rib spacing:
  - typically 12 mm

Negative ribs:

- vertical: rib spacing:
  - typically 3 mm
- diagonal: rib spacing:
  - typically 12 mm

Other rib configurations are available upon request.

Separators in warehouses are to be stored cool and dry. For storage periods up to 2 years no changes in the stated quality characteristics are to be expected.

The separators have to be protected against moisture pick-up until just before use. This is especially required for separators with glassmat which are delivered in special packaging.

For special applications of our products, e.g. in new developments, for which deviating requirements may be requested, we kindly ask you to contact us for the necessary technical discussions.

4/96

DARAK® 2000 Industrial

Product description

For more than 30 years DARAMIC, Inc. separators have been meeting all market requirements.

DARAK® 2000 Industrial is a microporous duroplastic separator invented by our R & D team. Due to its high temperature stability, low electrical resistance and very low acid displacement DARAK® 2000 Industrial is especially suited for applications in batteries with gelled electrolyte.

The DARAK® 2000 Industrial separator consists of a modified phenolic resin and an integrated polyester mat for reinforcement as well as a glue attached glassmat. Owing to its small average pore diameter of about 0.5 µm, this separator prevents penetration shorts.

DARAK® 2000 Industrial separators have a typical backweb thickness of 0.4 mm and integrated ribs, i. e. the ribs consist of the same material as the backweb.

For very high separator thicknesses the positive ribs are coated.

Typical values for 1.3 mm thick separators are:

Acid displacement: 165 ml/m²

Pore volume: 70 %

Average pore size: 0.5 µm

Maximum pore diameter: 1 µm

Quality characteristics

Separator dimensions

DARAK® 2000 Industrial with glassmat

	Unit	Value			Test method
Glassmat type		04	06	08	
Height	mm	96-600	96-600	96-600	BS-TE-2015
Width	mm	65-750	65-750	65-750	BS-TE-2015
Thickness – „diagonal" *	mm	1.4-2.85	1.6-3.0	1.8-3.2	BS-TE-2005
Thickness – „vertical" *	mm	1.4-2.85	1.6-3.0	1.8-3.2	BS-TE-2005
Thickness – „diagonal on both sides" *	mm	2.8-3.35	3.05-3.5	3.25-3.7	BS-TE-2005

Special dimensions available upon request.

* rib configuration

British Standards 6290 Part 4, Section 3.2

Terminal Pillars

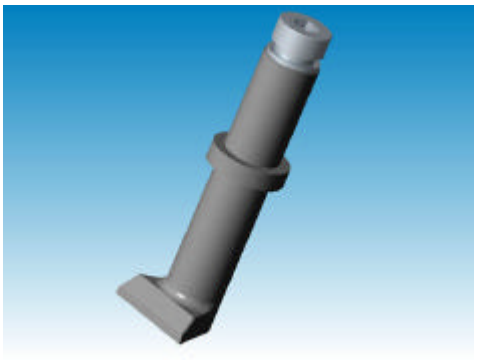
Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

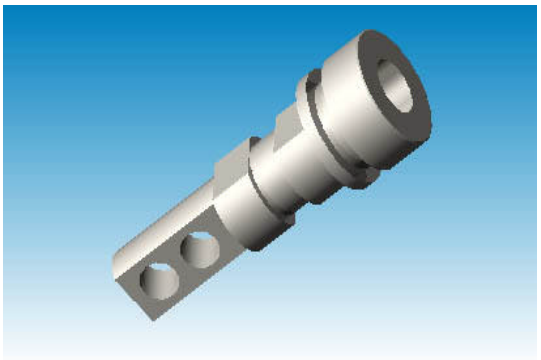
Requirements:

The terminal pillars shall be cast in lead alloy and contain 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.

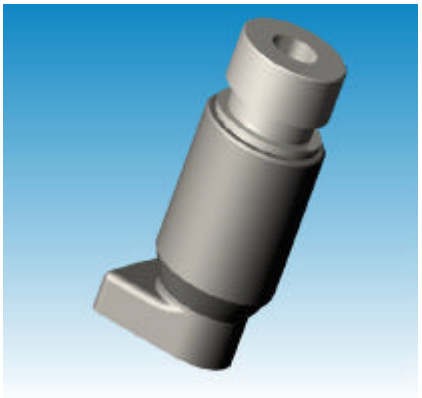
BPC specifications: **2 Volt bloc Gel & AGM**

BPC Gel and AGM pillars are manufactured as in the diagrams shown.
2V - Insert diameter is 18mm.





6&12 – Insert diameter varies from 12mm to 18mm depending on the size of the battery.



The image on the left shows the cast terminal post before assembly. The image on the right shows the terminal insert, which is cast in to the terminal pillar with numerous features to ensure excellent mechanical and electrical bonding.

Connection to the terminal is via a lug held firmly in place by a metric hex head bolt utilizing a spring and flat washer. The primary current path is from the flat surface of the terminal insert and the underside of the lug. Re-torquing of the bolt is not required.

British Standards 6290 Part 4, Section 3.3

Containers and Lids

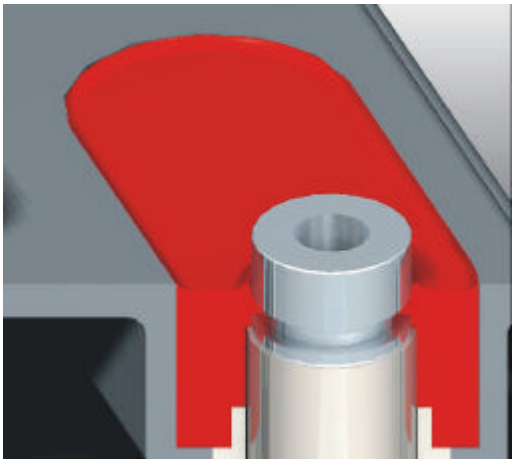
Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The containers and lids shall be made in a flame retardant plastics material and be so designed as to minimize flexing of the surfaces under normal operating pressures.
Note: The preferred plastics material is ABS, a range of copolymers based on the acrylonitrile butadiene styrene.
The lid shall be welded to the container, and the complete design shall be able to withstand without fracture for 5 hours at 20C an internal pressure of 5x the normal operating pressure declared by the manufacturer. The complete design includes a pillar to lid seal, which shall be designed to remain gas and electrolyte tight during the design life of the units.

BPC specifications: **2 Volt bloc Gel & AGM**

The containers, lids and valve assemblies are constructed from Flame retardant ABS conforming to the flammability classification of UL94 – V0 or IEC707-FV0.
The case to cover assembly is effected by the use of specially formulated ABS two-part epoxy, which gives excellent mechanical and chemical bonding. The epoxy is completely resistant to attack from Sulphuric acid.
The 2 Volt terminal seal is a combination of a mechanical crimp of a lead insert, which is moulded in to the case, and the use of epoxy and extended mechanical paths. The 6&12 Volt seal is effected by extended mechanical paths and application of two-part epoxy.
Under test the sealed units easily withstand a pressure of 20 PSI or 140Kpa for 5 hours.
The “double” sealing of the terminal pillar is impervious to acid penetration. A section is shown below.



British Standards 6290 Part 4, Section 3.4

Pillar Seal Assembly

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The pillar to lid seal shall be designed to remain gas tight and electrolyte tight during the design life of the units. When tested in accordance wi th Appendix 5 of the standard. The seal assembly shall, after 200 days on test, show no signs of acid penetration.

BPC specifications: **2 Volt bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

The test method of Appendix 5 of the standard is based on inverting the terminal area in acid and applying a current for a given period to test for acid penetration, unfortunately this test can not be performed on modern designs as the terminal insert is made from copper, nickel and silver plated brass which shows excellent resistance to environmental corrosion and reasonable resistance to sulphuric acid, but would corrode during the test if immersed in 1250 SG sulphuric acid.

A section of the terminal assembly is shown in the previous section.

British Standards 6290 Part 4, Section 3.5

Internal Intercell Connectors

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The internal intercell connectors shall prevent acid creepage through the intercell partition. They shall with stand a short circuit without detriment to the safety of the unit.

BPC specifications: **2 Volt bloc Gel & AGM**

BPC 2 Volt bloc are mono cells and therefore do not have intercell connectors.

BPC specifications: **6&12 Volt Monobloc Gel & AGM**

BPC 6&12 Volt Monobloc batteries are constructed with internal intercell connectors, which extend above and across the top of the battery case. The electrical connection is made by welding the top of the two intercell connectors together to a depth of approximately 5 mm. When the cover is assembled all the intercell welds are submerged in epoxy.

British Standards 6290 Part 4, Section 3.6

Valve

Batteries under consideration **2 Volt Bloc Gel & AGM**
6 & 12 Volt Monobloc Gel & AGM

Requirements:

The valve shall operate at the pressure and tolerance limits stated by the manufacturer. The valve shall not allow the ingress of air.

All BPC 2 Volt Bloc and 6&12 Volt Monobloc batteries utilize an EPDM safety valve of internal diameter 11.4mm, the valve stem diameter is 11.6mm.
The tested release pressure to date for all incoming SQC testing is 2 PSI +/- 0.5 PSI (14 KPa +/- 3.5 KPa) which is within the quoted spread of 1 to 3 PSI.

Valves are tested on valve stems of known size submerged in water, the release and reseal pressure is recorded. Typical reseal pressure is 1 PSI (7 KPa).

British Standards 6290 Part 4, Section 4.1

Rated Capacity

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

For the purpose of this standard, the rated capacity is the three hour rate (C_3) and shall be stated by the manufacturer.
When measured in accordance with A.1 of BS 6290 the stated rated capacity shall be achieved on the first discharge.

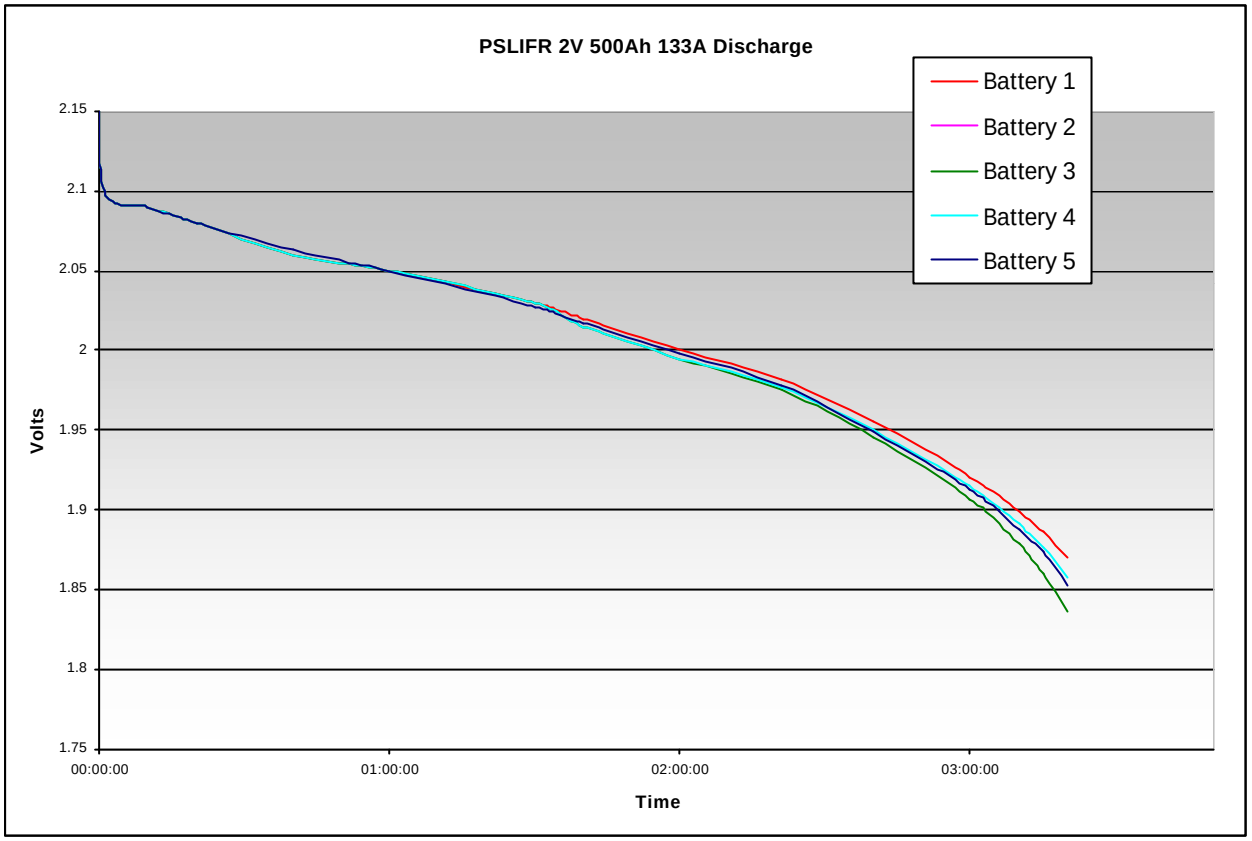
BPC specifications: **2 Volt bloc Gel & AGM**

It is industry recognised that Gel cells require cycling to achieve their quoted performance – usually 15 cycles, however the BPC 2V Gel cell will normally achieve quoted capacity after 3 cycles. Cells experience two discharge cycles in the factory as part of the final charging sequence. Below are the average results of 5 batteries tested straight from finished goods for three cycles. The batteries under test were 2V 300 Ah Gel. (PSLIFR 300-2) Discharged at 78A for 3 hours to 1.80 vpc.

First Cycle	224 Ah
Second Cycle	229 Ah
Third Cycle	234 Ah

BPC specifications: **2 Volt bloc AGM**

BPC 2 Volt AGM cells also undergo a charge discharge cycle as part of the final charging process and due to the nature of AGM will meet the quoted 3 hour capacity on the first discharge. See diagram of the test data for 5 pieces of 2V 500Ah AGM. (PSLIFR 500-2)



The resulting Ah for 3 hours of 400Ah was easily achieved without reaching the quoted cut off voltage of 1.8V.
AGM batteries also receive two discharge cycles as part of the final charging sequence and will achieve full capacity when they are packaged for delivery. Below are the results of 5 batteries taken at random from the finishing line. The batteries under test were 2V 500AH (PSLIFR 500-2) Discharged at 133A for 3 hours to 1.8 vpc.

BPC specifications: **6&12 Volt Monobloc Gel & AGM**

Gel
Three pieces of 12V 100Ah Gel (PSLGel 100-12) were taken at random from the finishing line and tested at 23.1A to 1.75 vpc.

Battery	Test 1	Test 2	Test 3
1	2hrs 54	2hrs 59	3hrs 06
2	2hrs 52	2hrs 58	3hrs 04
3	2hrs 56	3hrs 01	3hrs 08

AGM
Five pieces of 12V 150Ah AGM (PSLIFR 150-12) were taken at random from the finishing line and tested at 35.5.1A to 1.75 vpc.
Battery 1 – 3hrs 8 mins Battery 2 – 3hrs 6 mins Battery 3 – 3hrs 10 mins
Battery 4 – 3hrs 9 mins Battery 5 – 3hrs 10mins

British Standards 6290 Part 4, Section 4.2

Endurance in Charge / Discharge Cycles

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monoloc Gel & AGM

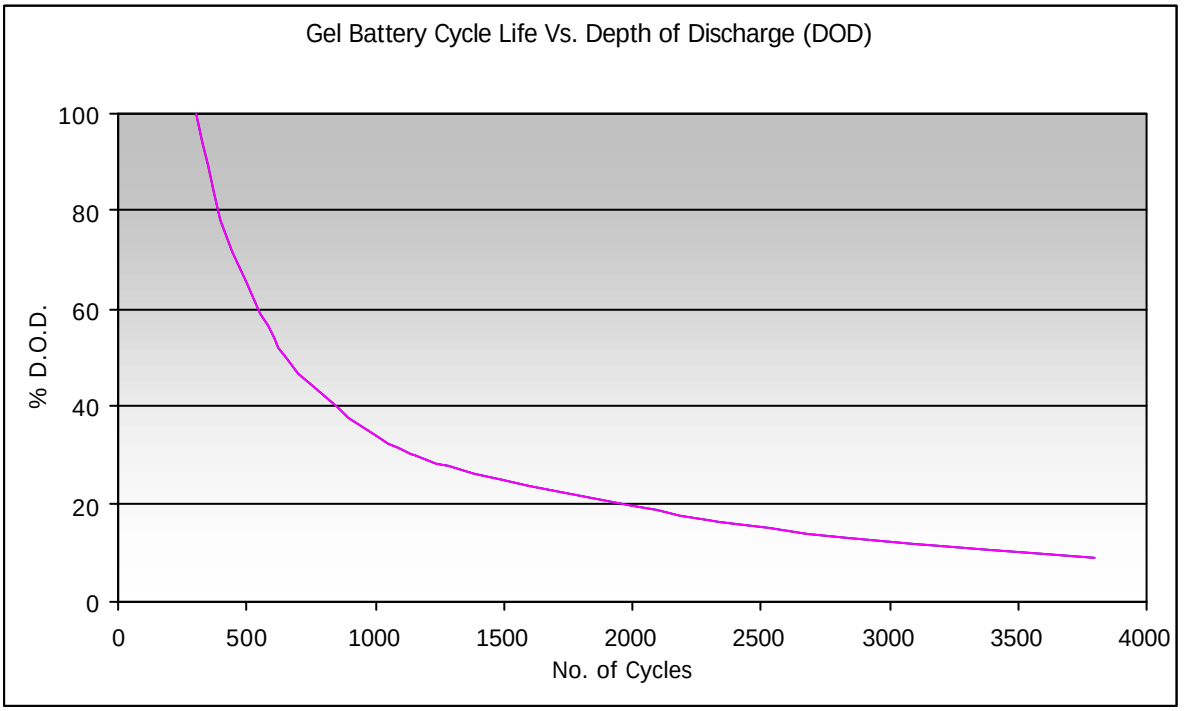
Requirements:

When measured in accordance with Appendix 3 of BS 6290 Part 1, 1983, modified by A1 of this standard the battery shall complete three series of cycling to a failure point of 0.95 C_3

The requirement of the standard is that the units undergo 150 cycles of less than 100 % depth of discharge (DOD) and requires the battery to deliver 150 Cycles before 95% of C_3 is reached.

BPC specifications: **Bloc and Monobloc Gel**

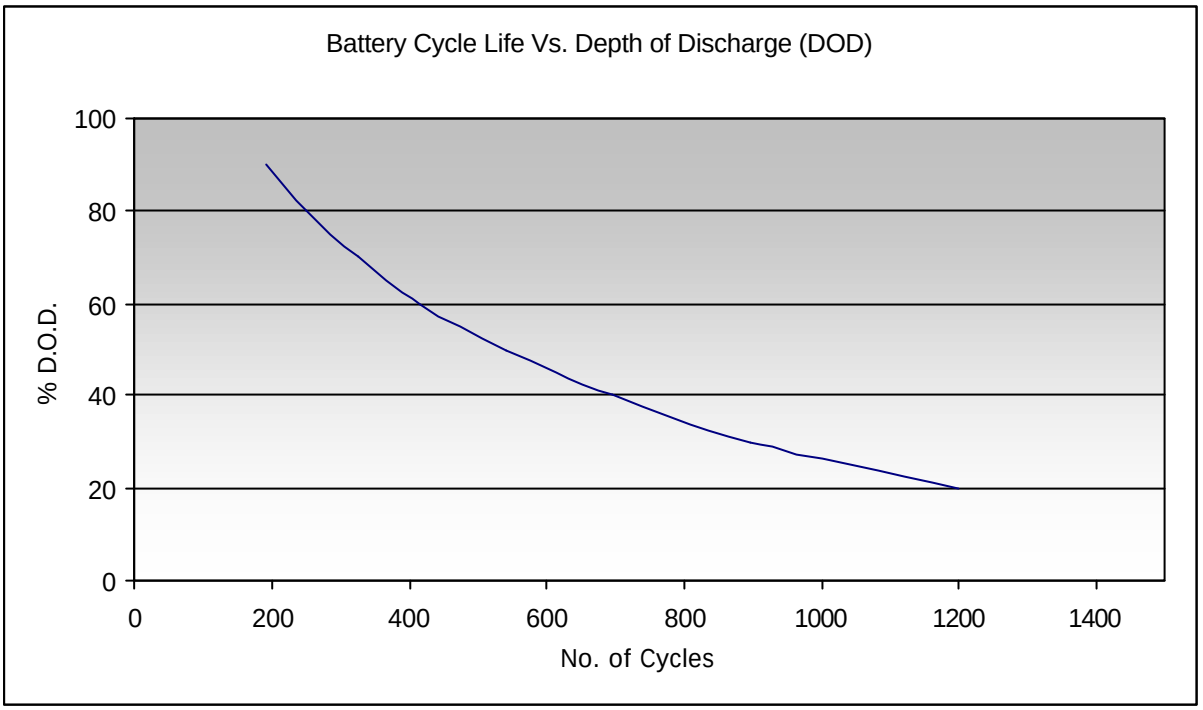
The Gel cell is easily capable of achieving this requirement cycle life is shown in the graph below.



After 150 cycles of 10% DOD the rated capacity is 97% of quoted capacity.

BPC specifications: **Bloc and Monobloc AGM**

The AGM battery is not so resilient to cycling as shown in the graph below.



After 150 cycles of 10% DOD the capacity would be 95% of the quoted C_3 capacity

British Standards 6290 Part 4, Section 4.3

Endurance at Constant Voltage

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

When measured in accordance with Appendix 2 of this standard no unit voltage shall fall below the average of the unit voltages by more than 2.5% during each 90 day period and the amp hour equivalent of gas released shall be less than 5% of the total ampere hours passed through the battery.

The manufacturer shall state the recommended float voltage in the type test certificate.

BPC specifications: **2 Volt bloc Gel & AGM**

2 Volt cells on a float voltage of 2.23 Volts per cell (VPC), gave the following results after the 90 day period.

Average voltage – 2.23 VPC
Total Deviation – 0.26%

Both AGM and Gel cells gave the same result well within the requirement set by this standard.

BPC specifications: **6&12 Volt bloc Gel & AGM**

Two 6 Volt and two 12 2 Volt cells were connected in series and parallel on a float voltage of 2.23 Volts per cell (VPC), gave the following results after the 90 day period.

Average voltage – 2.23 VPC
Total Deviation – 0.63%

Both AGM and Gel cells gave the same result well within the requirement set by this standard.

The volume of gas evolved from all the test batteries over this period was less than the lower limits of detection of the test apparatus. The loss of liquid was not detectable by weighing the cells either. According to the standard 1Ah passed through the cell is equivalent to 449 ml of Hydrogen at 20C. Due to the very low internal resistance of the 2 Volt cells is concluded that the gas released over this period is a fraction of the requirement of the standard, which is more biased towards 12V units.

British Standards 6290 Part 4, Section 4.4

Endurance under Mechanical Stress

Batteries under consideration **2 Volt Bloc Gel & ASM**
6&12 Volt Monobloc Gel & AGM

Requirements:

When measured in accordance with Appendix 3 of this standard six units shall remain gas-tight and any change of performance at the 5 min rate of discharge shall not be greater than 10%.

BPC specifications: **2 Volt bloc Gel & AGM**

Cells were tested at the quoted 5 minute discharge rate (Note cells were connected in series to give a 12 Volt system) the units showed no sign of any mechanical stresses induced by the discharge and the duration of test variation was less than 1%.

BPC specifications: **6&12 Volt bloc Gel & AGM**

Cells were tested at the quoted 5 minute discharge rate (Note cells were connected in series to give a 48 Volt system) the units showed no sign of any mechanical stresses induced by the discharge and the duration of test variation was less than 3%.

British Standards 6290 Part 4, Section 4.5

Endurance under Short Circuit Conditions

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

When measured in accordance with Appendix 4 of this standard the capacities of three units measured before and after the 1 min short circuit test shall be equal to or greater than the unit C3 capacity stated by the manufacturer.

The unit subjected to the 24-hour short circuit test shall show no indication of smouldering or fire and it shall not explode.

BPC specifications: **2, 6&12 Volt Bloc and Monobloc Gel & AGM**

The BPC 2 Volt cells showed no loss of capacity as a result of the 1 minute short circuit test, terminal post temperature readings reached a maximum of 42 °C.

The units subjected to the 24 hour short circuit test showed no signs of smouldering or fire and did not explode. Maximum terminal temperature recorded was 51 °C.

British Standards 6290 Part 4, Section 4.6

Conservation of Charge

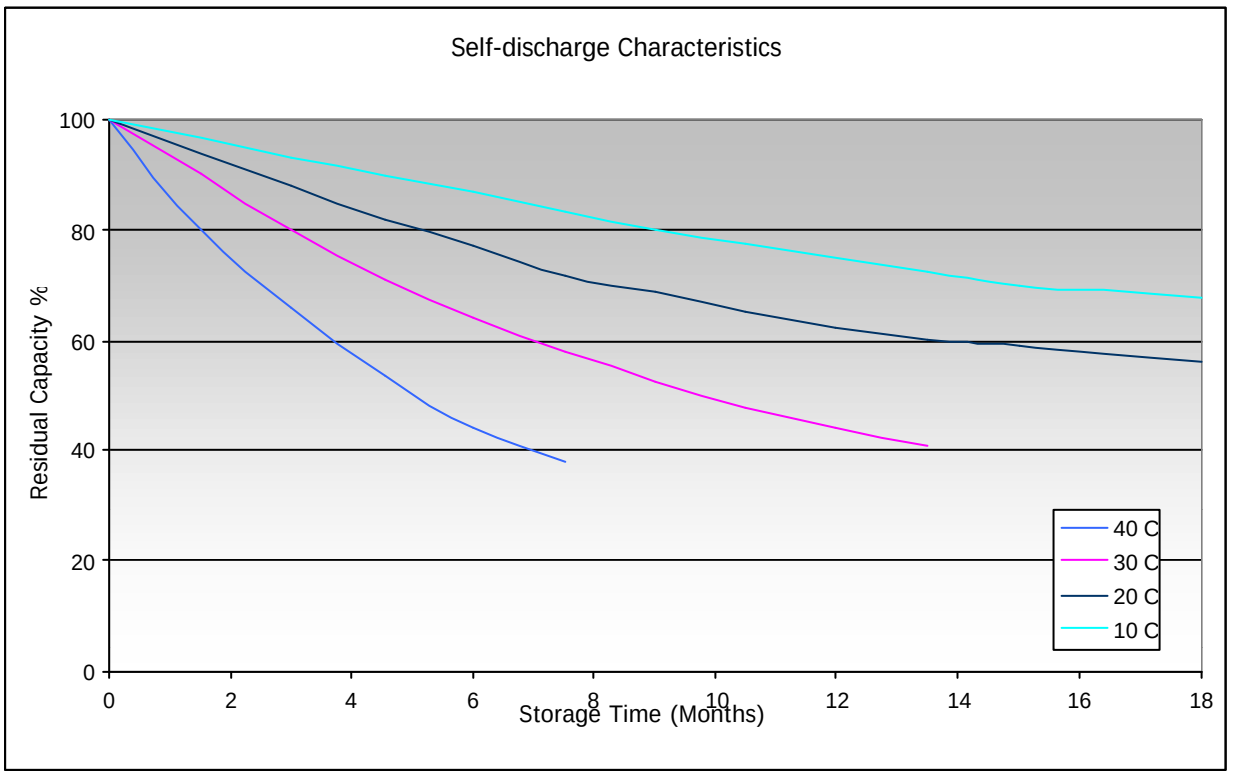
Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc AGM

Requirements:

When measured in accordance with Appendix 5 of BS 6290 Part 1, 1983, as modified by appendix 1 of this standard, the percentage loss of capacity shall not exceed 28%

BPC specifications: **2 Volt bloc Gel & AGM**

Twenty four units of PSLGel 200-2 and PSLIFR 200-2 were fully charged and floated at 2.23 VPOC for 24 hours. The units were then placed on open circuit. The standard requires the test duration be 360 days, the batteries were open circuit for 180 days after which a discharge test was performed the % remaining capacity of the Gel cells was 93% and the AGM cells 78%. The graphs below show the expected capacity loss at various temperatures.



BPC specifications: **6&12 Volt Monobloc Gel & AGM**

Four units of PSLGel 100-12 and PSLIFR 100-12 were fully charged and floated at 2.23 VPOC for 24 hours. The units were then placed on open circuit. The standard requires the test duration be 360 days, the batteries were open circuit for 180 days after which a discharge test was performed the % remaining capacity of the Gel cells was 91.5% and the AGM cells 79%. The graphs above show the approximate expected capacity loss at various temperatures.

British Standards 6290 Part 4, Section 4.7

Short Circuit Current

Batteries under consideration **2 Volt Bloc Gel & AGM**
6 & 12 Volt Monobloc AGM

Requirements:

When measured in accordance with Appendix 6 of BS 6290 Part 1, 1983, as modified by appendix 1 of this standard, the short circuit current, Is, shall not exceed that stated by the manufacturer in the type test certificate.

BPC specifications: **2, 6&12 Volt Monobloc and Bloc Gel & AGM**

The short circuit current is normally determined by measuring the impedance. The worst-case calculation is as follows.

Is = 2.3 x no of cells in the battery / impedance

The impedance of a 2 volt cell is very difficult to measure due to the very high surface area of the cell. However a guide for maximum discharge current is quoted for all battery models.

British Standards 6290 Part 4, Section 4.8

Flammability of Non- Metallic parts

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The flammability of non-metallic parts shall be stated by the manufacturer. when tested in accordance with method FV of BS6334, it shall comply with that stated by the manufacturer.

BPC specifications: **2, 6&12 Volt Bloc and Monobloc Gel & AGM**

See also section 3.3 Containers and lids.
The flammability of all Non-metallic parts as classified by UL94 is V0. In addition each 2V valve assembly contains an integral FRIT (flame arrestor) above the safety valve.

British Standards 6290 Part 4, Section 7.0

Identification

Batteries under consideration **2 Volt Bloc Gel & AGM**
6&12 Volt Monobloc Gel & AGM

Requirements:

The cell / Battery container or lid shall carry identification marks indicating the unit type, nominal voltage, month and year of manufacture and the manufacturers name.

Marking shall be carried out to indicate clearly the positive terminal and shall take the form of a + symbol indented or in relief on the upper surface of the terminal or on the lid adjacent to the positive terminal.

All marking shall be durable and permanently fixed.

The manufacturing data for each battery is marked by the use of a date code hot stamped on to the battery cover.

All positive and negative terminals are clearly marked by + and – symbols moulded in to the plastic, along with the use of red epoxy for positive terminals and black epoxy for negative terminals.