THE EN/IEC STANDARDS 60896-21 and -22 FOR STATIONARY VALVE REGULATED LEAD ACID BATTERIES. THEIR STRUCTURE, APPLICATION MODE AND SOME COMPLIANCE DATA

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INTRODUCTION

Stationary Lead Acid Batteries of the VRLA (valve regulated) type are the choice power backup storage batteries for telecommunication and data networks and for uninterruptible power supplies. They are produced in many designs and in many countries of the world.

Their specifications and performances are traceable to numerous commercial, national and international standards, each with its set of requirements. These varying requirements reflect local customs, priorities or operational experiences, and their diversity is not very helpful to procure comparable batteries from different suppliers without expensive prior testing.

In April 2000, the International Electrotechnical Commission (IEC), a leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies, instructed its Technical Commission 21 (TC 21), responsible for standards for secondary cells and batteries, to reformulate and update the ancient IEC Standard 896-2 for Stationary Lead Acid Batteries – Valve regulated types, published in 1995.

The author, together with Mr. M. Kniveton of British Telecom, served as the leaders of a working group of international battery expert and prepared the publication of the revised twin standards, IEC 60896-21 Stationary Lead Acid Batteries – Part 21: Valve Regulated Types – Methods of Test and IEC 60896-21 Stationary Lead Acid Batteries – Part 22: Valve Regulated Types – Requirements, in February 2004.

By an agreement between IEC and Cenelec, the European Committee for Electrotechnical Standardization, by which Technical Standards elaborated in the framework of IEC become, with identical content, an European (EN) Standard, both 60896-21 and –22 Standard designations received the EN (European Norm) prefix with identical numbering. Within a period of nine months, these two EN Standards had to be published by each of the 28 member committees in the language of their choice and their voluntary implementation started. By March 2007, all national standards relating to Stationary Lead Acid Batteries of the VRLA type have to be withdrawn within the 28 European countries forming Cenelec and solely EN 60896-21 and –22 left in use.

One of the key features of the new Standard EN/IEC 60896 is the fact that it has been split into two complementary bodies with –21 designating the part dealing with methods of test and –22 designating the part with the resulting requirements or desired outcomes of the tests. This split was strongly favored by the battery user experts of the working group, as it allows having a common method of test and modulating and revising the requirements as a function of changing duties of these stationary batteries.

In the EN/IEC 60896-21 standard, a total of 21 clauses or methods of test are defined for the quantification of properties and characteristics of all types of Valve Regulated Stationary Lead Acid Batteries for float charge application in a static location and incorporated into stationary equipment or installed in battery rooms for use in telecom, uninterruptible power supply (UPS), utility switching, emergency power or similar applications.

The content covers housekeeping aspects, such as sample selection and documentation, and the exact description of the experimental procedures for the tests to determine their Safe Operation, Performance and Durability characteristics.

In the EN/IEC 60896-22 part of the standard, three mirror sets of a total of 21 requirements have been elaborated by the working group. In the set for Safe Operation, the compliance to a single requirement is mandatory, whereas, for Performance and Durability, the requirements are staggered based on the intended use or environmental conditions. The rationale for the test methods, the communication between battery specifier and battery manufacturer, and the rationale for the selected requirements, together with some actual results, are shown below.

THE IEC STANDARD WRITING PROCESS

The writing of standards by IEC (see also www.IEC.ch) occurs in the framework of official working groups (WG1, WG2, WG3 etc.) whose members are nominated by their respective national mirror committees. These national committees (NC) are in turn accredited members of a particular Technical Commission of IEC and are defined either as coming from participating or observer member countries. TC21 Secondary Cells and Batteries has 16 Observer and 22 Participating National Committees, i.e. countries, and deals exclusively with Lead Acid Batteries. Its Subcommittee SC21A is responsible for secondary cells and batteries containing alkaline or other non-acid electrolytes. The US National Committee resides in New York and can be reached under www.ansi.org and czegers@ansi.org.

The standard work generally starts from a proposal stage (document submitted by a NC). A simple majority vote of members on the interest of studying the proposal takes place within three months. If the result is positive and a minimum of four members or 25 % of the P-members, whichever is greater, undertake to participate actively in the work and nominate experts, it is included in the IEC TC 21 work program, together with a project plan, including target dates. From this moment on, and after the selection of a working group leader, the work progresses via Committee Drafts (CD), Committee Drafts for Voting (CDV), through a Final Draft of International Standard (FDIS), to the ultimate standard text.

The content of the standard is shaped in the WG sessions (2-4 per year) by personal input from WG members and ad-hoc, invited experts, and by the official input or feedback (comments) from each national committee in which the respective WG member is normally also active. This process is intended to balance personal and company vs. national interests in the content of the standard.

Before passing to the approval stage, the bilingual (F/E) Committee Draft for Vote (CDV) is submitted to all national committees for a five-month voting period. It is the last stage at which technical comments can be taken into consideration. The CDV is considered as approved if a majority of two thirds of the votes cast by P-members are in favor, and if the number of negative votes cast by all national committees does not exceed one quarter of all the votes cast.

In the shaping of the IEC 60896-21 and –22 standards, the TC21 WG3 met successively in Kyoto (04/2000), Phoenix (09/2000), Nice (01/2001), London (05/2001), Edinburgh (09/2001), Frankfurt (02/2002), Rome (06/2002), Montreal (09/2002), and Stockholm (06/2003), and the work path passed through one CD, one CDV, and one FDIS before being approved by the vote closing on 01.09.2004. In this vote, 19 P-Members of TC21 participated and, of those, 16 voted in favor and 3 abstained. The USA, although active in the preceding voting stages (CDV), did not participate in the FDIS vote, together with India and Romania.

Once the IEC Standard is published, its contents flow either on a one-to-one basis, by the so called parallel vote procedure, into a Cenelec or European Standard or, with adaptations, into Non-European National Standards (Japan, Australia, Brazil etc.).

Each IEC standard is submitted to a periodic IEC-mandated maintenance or full-fledged revision. This review can consist in amendments or the complete overhaul of the text. Amendments are then published as annex to the main standard body. For the IEC 60896-21, the next revision is planned, to give test condition stability, only for 2011. The IEC 60896-22 will be entering its first maintenance in 2009 so as to be able to adjust technical requirements as battery applications evolve.

EN/IEC 60896-21 – THE STANDARD FOR THE METHODS OF TEST OF STATIONARY VRLA BATTERIES

The methods of test selected in this new standard are heavily oriented toward giving the battery user concrete data concerning the potential behavior in his installation and reflect also the current practice for such tests in different national standards.

Standards "visited" for input were the IEC 896-2, BS 6290, ANSI T1 330, IEEE-1187, 1188 and 1189, TR-NWT-000766, EN 50272:2 and Company Internal Standards.

The reference capacity test has newly been defined as the 3h rate discharge test to 1.70Vpc, with the reference temperature either being 20°C (68°F) or 25°C (77°F). In a later revision, the migration to the 25°C reference temperature is planned, together with a single "stress" temperature. The float voltage during high temperature test is that specified for 25°C (77°F).

Table 1. Purpose of Verification Tests

Test clause	**Safe Operation Characteristics**	
6.1	Gas emission	To determine the emitted gas volume
6.2	High current tolerance	To verify the adequacy of current conduction cross-sections
6.3	Short circuit current and DC internal resistance	To provide data for the sizing of fuses in the exterior circuit
6.4	Protection against internal ignition from external spark sources	To evaluate the adequacy of protective features
6.5	Protection against ground short propensity	To evaluate the adequacy of design features
6.6	Presence and durability of required markings	To evaluate the quality of safety information markings
6.7	Material identification	To ensure the presence of material identification markings and compliance with environmental standards
6.8	Valve operation	To ensure the correct opening of safety valves
6.9	Flammability rating of materials	To verify the fire hazard class of battery materials
6.10	Intercell connector performance	To verify the safety margin based on maximum surface temperatures during high rate discharges
Performance Characteristics		
6.11	Discharge capacity	To verify the available capacities at selected discharge rates or discharge durations.
6.12	Charge retention during storage	To provide storage duration data
6.13	Float service with daily discharges	To determine cyclic performance under float charge conditions
6.14	Recharge behavior	To determine the restoration of power back-up availability after a power outage
Durability Characteristics		
6.15	Service life at an operating temperature of 40 °C	To determine the anticipated operational life at elevated temperatures
6.16	Impact of a stress temperature of 55 °C or 60 °C	To determine the influence of high stress temperatures on cell or monobloc battery life
6.17	Abusive overdischarge	To determine the expected behavior when excessive capacity is discharged
6.18	Thermal runaway sensitivity	To determine the expected times to establish a condition of escalating current and temperature
6.19	Low temperature sensitivity	To determine the sensitivity toward damage induced by electrolyte freezing
6.20	Dimensional stability at elevated internal pressure and temperature	To determine the propensity of the cell or monobloc to be deformed by internal gas pressure
6.21	Stability against mechanical abuse of units during installation	To determine the propensity of the cell or monobloc battery to fracture or leak when dropped.

Test sample selection

As each manufacturer has several dozen of VRLA cells and monoblocs in his product portfolio, it was agreed among the battery user and battery manufacturer experts in the working group, and sanctioned by a yes vote at FDIS level, that it would be technically and economically cumbersome to submit each unit in the portfolio to the full-fledged 21 tests. For this purpose, the thorough and well documented testing of representative batteries was codified, with the idea that it is better to provide the customer solid data from a limited set instead of incomplete data acquired in a shotgun approach from widely different units.

The sample selection is based on the definition of product ranges, where common features allow describing, with a test carried out on one cell or monobloc model, the behavior of the remaining types in the product range.

The product range has been defined in IEC 60896-21 under 3.29 as: Range of products, i.e. cell and monobloc batteries, over which specified design features, materials, manufacturing processes, and quality system (e.g. ISO 9000) of the manufacturing location are identical.

From within this product range, a representative cell or monobloc battery model shall be selected such that this model has the most critical features regarding the outcome of the greatest number of tests. The same model within the product range shall then be submitted to all tests to qualify and document the entire product range except for clause 6.2, current per terminal and clause 6.3, information on the unit. The number of test units for each test clause varies from 1 to 7.

It is then up to the battery specifier and user to make sure that this product range definition is reasonable and not unduly stretched for the sole benefit of the battery manufacturer. On the other hand, the battery specifiers and users are asked to refrain from pushing to have further units tested just because the tested one is not the model they want to buy. Such custom testing requires between one to two years to be carried out, and any newly started testing certainly would not meet a tight deadline for submitting them for any product procurement process.

The following product range definition has been implemented by my company.

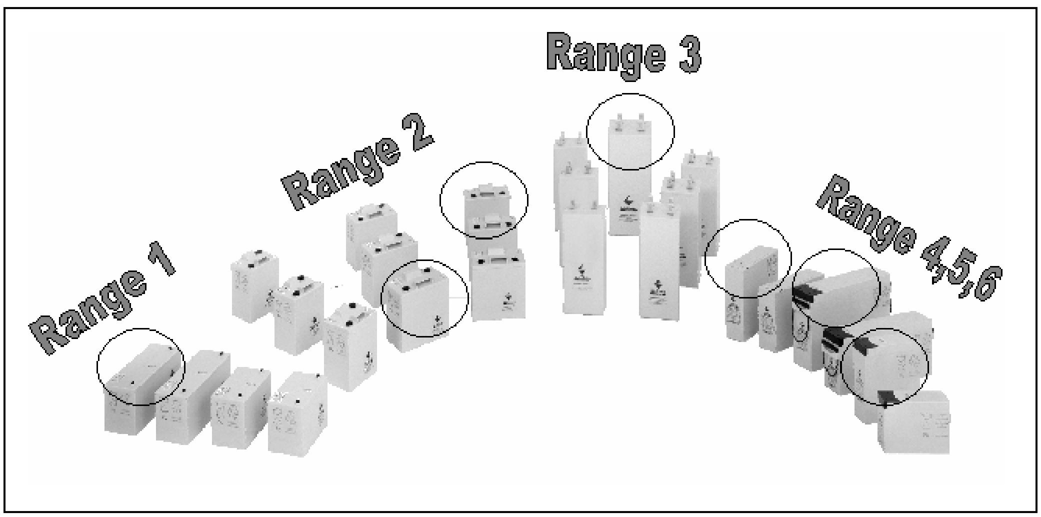

Figure 1. Example of a VRLA product portfolio, the product ranges therein, and the test units (circled) on which the tests, according to IEC 60896-21 test clause 1 to 21, are to be carried out.

Test documentation

In the interest of the credibility of the test results and to protect those who carry out this product property quantification program, the standard specifies that the test units and test setup have to be documented with photographs and no exceptional preparation conditions or treatment are allowed. The possibility of calling up this clause-by-clause test documentation by the battery specifier and user in a RFP or RFQ situation is expressly foreseen in the standard.

Requalification tests

Whenever there is a significant change in a specified design feature, material, manufacturing process, relevant quality inspection and test procedures and manufacturing location(s) of a product range, the relevant test(s) shall be repeated to ensure that the affected product range continues to be in compliance with the defined Safe Operation, Performance and Durability requirements for the intended application.

EN/IEC 60896-21 – THE TEST CLAUSES FOR SAFE OPERATION CHARACTERISTICS

The test clauses for Safe Operation incorporate those experimental activities deemed necessary to evaluate properties related to basic battery operation and disposal and associated needs of information.

The test clauses cover the following items:

Table 2. Test Clauses for Safe Operation Characteristics

Clause	Test of	Test condition	Test result reporting
6.1	Gas emission	Float at 2.xx float voltage and 2.40Vpv 168h/48h	Report gas volume in ml/h/Ah at 2.xx and 2.40Vpc
6.2	High current tolerance	Discharge with 3x the 5 Minute current for 30s	Report inspection and damage
6.3	Short circuit current and DC internal resistance	Discharge and measure voltage with 4xI10 20s and 20xI10 5s	Report Iscc in A and IR in Ohm
6.4	Protection against internal ignitions	Submit valve assemblies to IEC TN 61430(1997) spark test	Report reaction to sparks
6.5	Protection against ground short propensity	Float at 2.xx float voltage and superimpose 500V DC vs. ground for 30/7/7/7d	Report ground shorts after tests in all orientations
6.6	Presence and durability of required markings	Expose to chemicals and inspect	Report print stability and information content
6.7	Material identification	Inspect for ISO 1043 material code on battery	Report proper material identification
6.8	Valve operation	Inspect valve operation before/after 55°/60°C test	Report proper operation
6.9	Flammability rating of material	Test case/cover according to IEC 60707 and IEC 60695-11-10 50W flame	Report rating achieved
6.10	Intercell connector performance	Discharge with 0.25h rate to 1.60Vpc and measure temperature	Report connector details and temperature

These tests can be distinguished in current flow/gas emission and in battery operation related ones. The gas emission test takes in consideration that, in the Cenelec world, the EN 50272:2:2001 Standard regulates the battery ventilation aspects and that actually lower, and experimentally determined gas emission values do not allow to reduce the statutory ventilation air exchange requirements given by the formula Q=0.05 x Cells x 1(at float Voltage) x Ah (10h) x 0.001 in m^3/h.

Clause 6.5, ground short propensity, takes in account that a tight assembly is often encountered with VRLA installations and that potential electrolyte egress from the cell or monobloc could cause dangerous ground short conditions. This is a new test and involves the imposition of a 500V DC to ground voltage stress across seal lines for a total of 51 days with cells and monoblocs operated in horizontal conditions.

Clauses 6.6 and 6.7 look for a minimum of information concerning battery operating instructions on labels and for a battery recycling oriented material identification code.

EN/IEC 60896-21 – THE TEST CLAUSES FOR PERFORMANCE CHARACTERISTICS

These test clauses cover the basic performance data of the VRLA battery and give answers to questions such as: *how is the real capacity compliance, how large the self-discharge in storage , how good the cycle performance and charge acceptance?*

Table 3. Test Clauses for Performance Characteristics

Clause	Test of	Test condition	Test result reporting
6.11	Discharge capacity	Discharge a total of 30 units at the 10h, 8h, 3h, 1h and 0.25h rate	Report duration/capacity compliance achieved
6.12	Charge retention during storage	Store OC at 20° to 25°C for 180 days	Report 180d storage capacity retention factor
6.13	Float service with daily discharges	Discharge daily with 2I10 for 2h and recharge for 22h with 2I10 and 2.xx Vpc	Report cycles under float, under float & 168h charge and boost charge condition
6.14	Recharge behavior	Discharge with I10 to 1.80Vpc Recharge 2.xx Vpc for 24h and 168h.	Report capacity available after 24h and 168h of 2.xx Vpc recharge

Of these test clauses, clause 6.13 Float service with daily discharges, reflects a paradigm change in evaluating cycle life. Whereas in the ancient IEC Standard 896-2, the VRLA cycle life was evaluated by giving the tester the possibility to use boost voltages or somewhat artificial charge conditions, the new test replicates more closely the actual operation in the field, where the float voltage is the maximum voltage available for recharge. This means that more realistic cycle life data are generated when this test is carried out. The 40% (10h rate) d.o.d cycle followed by a 22h recharge reproduces a severely instable electrical power network or the utilization of the battery as peak power shaving device.

In clause 6.14, the recharge behavior is evaluated not just in terms of ampere hours accepted but in terms of capacity available after 24 or 168h of charge in the follow up discharge. This condition reproduces more closely real life.

EN/IEC 60896-21 – THE TEST CLAUSES FOR DURABILITY CHARACTERISTICS

These test clauses are designed to elicit answers to "*how-long-will-the-battery-last*" questions. The test conditions selected bring the VRLA cells and monoblocs to and also beyond the edge of their typical application envelope. The intention was to allow room for durability enhancement by stimulating the development of more rugged VRLA designs or/and for rewarding those who have such solutions already implemented but are smothered by generic durability specifications.

In clause 6.15 and 6.16, the service duration at permanent high temperature conditions is explored. One condition, at 40°C or 104°F, is declared an actual operating temperature of a VRLA battery and the achieved service duration, before the 3h capacity drops below 80% is determined. No added mechanical stabilization of the cell or monobloc, beyond that regularly supplied, is allowed, and the test is carried out in air, with a relative humidity level not above 35% and the float voltage as that rated for 25°C (77°F).

The high temperature or "stress" test is carried out at either 55°C (131°F) or 60°C (140°F), again to 80% residual capacity at the 3h rate. This condition is declared an abusive operating condition and added mechanical stabilization is allowed.

For both tests, IEC 60896-21 and –22 does not plan or encourage any extrapolation of the obtained duration values to room temperature life, as potentially too optimistic values could be extrapolated.

In clause 6.17, abusive deep discharge conditions are induced, which replicate either conditions of poor replacement stock, charge control or forced discharges to 1.25Vpc. Again, this is a new test and reflects input from battery operators.

Thermal runway is one of the failure methods of VRLA cells and monoblocs when, through internal defects or poor external charge or temperature control, excessive current flows though the battery, and temperatures as high as the boiling point of water are reached.

Table 4. Test Clauses for Durability Characteristics

Clause	Test of	Test condition	Test result reporting
6.15	Service life at an operating temperature of 40°C	Float at 40°C in dry air and 2.xx Vpc (for 25°C) and follow C3 capacity	Report days achieved to 80% residual capacity
6.16	Impact of a stress temperature of 55°C or 60°C	Float at 55°C or 60°C in dry air and 2.xx Vpc (for 25°C) and follow $C_3/C_{0.25}$ capacity	Report days achieved to 80% residual capacity
6.17	Abusive Overdischarge (1)	Discharge to 130% of rated C_{10} capacity and recharge with 2.xx Vpc for 168h	Report C_{aod} capacity ratio before/after over-discharge
6.17	Abusive Overdischarge (2)	Discharge 3 times with I_{10} to 1.25Vpc and recharge with 2.xx Vpc for 168h	Report C_{aoc} capacity ratio before/after over-discharge
6.18	Thermal runaway sensitivity	Float at 2.45Vpc and 2.60Vpc for 168h or to 60°C in defined layout	Report times, currents and temperatures of units in test layout
6.19	Low temperature service	Discharge with I_{10} to 1.80Vpc, cool 72h at -18°C, thaw up, recharge 168h, determine capacity	Report C_{als} capacity ratio before/after freezing cycle
6.20	Dimensional stability at elevated internal pressures	Pressurize at 50°C and determine change in dimensions	Report change in dimensions before/after pressurizing
6.21	Stability against mechanical abuse during installation	Drop twice on edges and corners from specified heights	Report damages

The sensitivity toward thermal runaway is governed by the heat dispersion capability of the battery and, depending on environmental conditions, the selection of one or the other VRLA design (Gel vs. AGM; Single Cell vs. Monobloc; Horizontal vs. Vertical Operation) may be an issue.

Without understandably being able to reproduce all thermal conditions, the test clause 6.16 offers test parameters to generate comparable sets of temperature rise conditions when a string of 6 cells and monoblocs is charged under controlled layout and airflow conditions at 2.45Vpc and 2.60Vpc. An indicator of thermal runaway sensitivity, the elapsed time to 60°C (140°C) wall temperature, or its value after 168h, is generated.

As VRLA batteries can experience conditions in which electrolyte freezing may occur, one test, specified in clause 6.19, calls for the freezing, at –18°C or 0°F, of the electrolyte of a cell or monobloc discharged at the 10h rate to 1.80Vpc. Again here, VRLA design related sensitivities exist, and the test outcome may help the battery specifier select the most appropriate design.

EN/IEC 60896-22 – THE STANDARD FOR REQUIREMENTS FOR STATIONARY VRLA BATTERIES

This standard and its content take origin in the test clauses of EN/IEC 60896-21 and serve as the vehicle with which the requirements or the desirable outcome of the tests are communicated.

This deliberate split has been made to allow for multiple VRLA battery performances which nevertheless have been measured under the same conditions. It was the intention of the WG3 experts not to declare, by selecting a particular test outcome over another, one battery superior to the other on the green table. This choice has to be made by each battery specifier or user independently, as he is fully aware what his operating conditions are and how deep his pockets are.

For essential Safe Operation Tests, only one outcome or compliance is required. For Performance and Durability Tests, multiple outcomes are allowed in certain clauses which, in turn, determine how much each unit or product range is suitable to meet operator requirements.

To guide this selection and also to improve communication between battery user and manufacturer in this critical phase, a decision tree and two templates, called Annex A and B, have been prepared and are an integral part of the Standard.

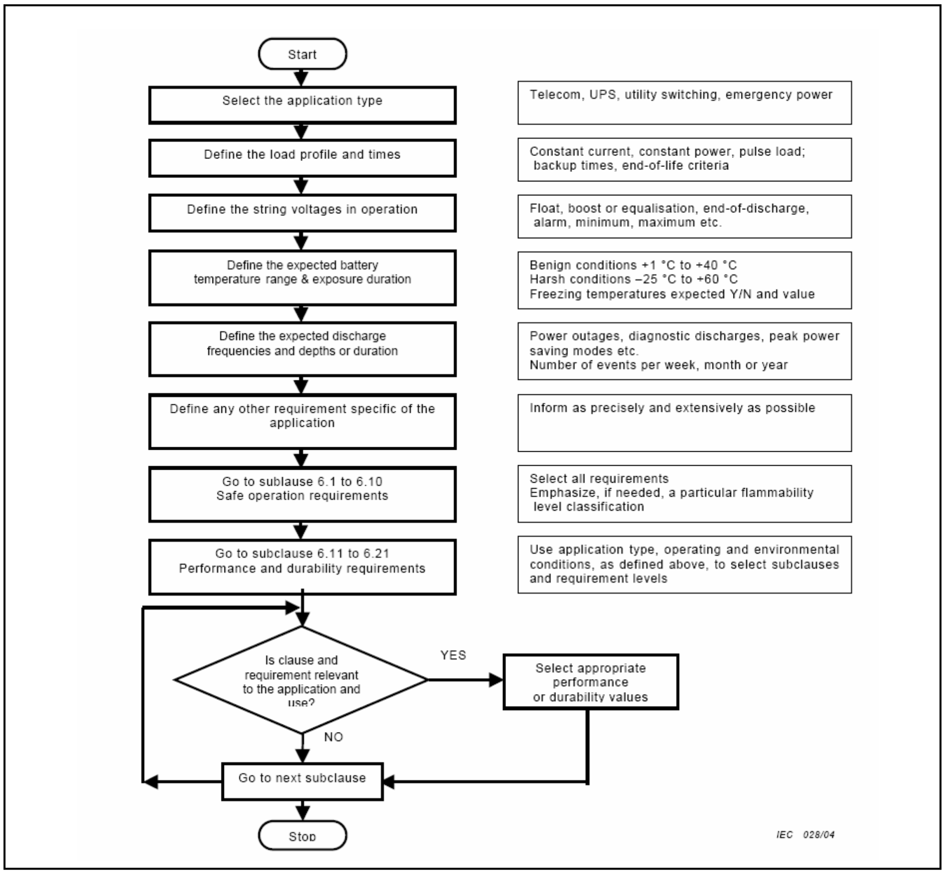

Figure 2. Decision tree in EN/IEC 60896-22 intended to guide in the selection of the appropriate requirements and the completion of ANNEX A.

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Annex A
(normative)

User statement of requirements

1) Application description information							
Application summary							
Load (in A or W) and autonomy time profile(s)							
Minimum and maximum system float voltage							
Maximum or boost charge system voltage available Y/N If yes what value?							
Minimum system discharge voltage or low voltage disconnect Y/N If yes what value?							
Expected minimum and maximum operating temperatures and their duration per year							
Any other relevant information or operational requirements such as duration and frequency of power outages, of diagnostic discharges and of energy cost saving actions							
2) Product specification information							
Product safe operation in service		**Compliance information mandatory**					
6.1	Gas emission (at float voltage and at 2,40 Vpc)	Data requested					
6.2	High current tolerance	Pass					
6.3	Short circuit current and d.c. internal resistance	Data requested					
6.4	Internal ignition from external spark sources	Pass					
6.5	Protection against ground short propensity	Pass					
6.6	Content and durability of required markings	Pass					
6.7	Material identification	Pass					
6.8	Valve operation	Pass					
6.9	Flammability rating of materials	Data requested					
6.10	Intercell connector performance	Data requested					
Product performance in service		**Compliance information mandatory or on as-needed basis**					
6.11	Discharge capacity	Data for	C_{10}	C_8	C_3	C	$C_{0.25}$
6.12	Charge retention during storage	Pass					
6.13	Float service with daily discharges	Value to be requested as function of service environment					
6.14	Recharge behaviour	Pass					
Product durability in service		**Compliance information mandatory or on as-needed basis**					
6.15	Service life at an operating temperature of 40 °C	Value to be requested as function of service environment					
6.16	Impact of a stress temperature of 55 °C or 60 °C	Value to be requested as function of service environment					
6.17	Abusive over-discharge	Value to be requested if service environment warrants					
6.18	Thermal runaway sensitivity	Pass and show data					
6.19	Low temperature sensitivity	Value to be requested if service environment warrants					
6.20	Dimensional stability at elevated internal pressure and temperature	Show data					
6.21	Stability against mechanical abuse of units during installation	Pass					

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Annex B
(normative)

Supplier statement of product range test results

1) General product type information						
Product manufacturer						
Manufacturing site of tested product						
Product name						
Product model range						
Product comprising the above model range						
Product tested						
2) Product test performance information						
Product safe operation in service		**IEC 60896-21 test clause result**				
6.1	Gas emission (at the float voltage and at 2,40 Vpc)					
6.2	High current tolerance					
6.3	Short circuit and d.c. internal resistance					
6.4	Internal ignition from external spark sources					
6.5	Protection against ground short propensity					
6.6	Content and durability of required markings					
6.7	Material identification	Case	Cover			
6.8	Valve operation	Before	After			
6.9	Flammability rating of materials	Case	Cover			
6.10	Intercell connector performance					
Product performance in service		**IEC 60896-21 test clause result**				
6.11	Discharge capacity	C_{10}	C_8	C_3	C	$C_{0.25}$
6.12	Charge retention during storage					
6.13	Float service with daily discharges	Cycles	C_{af}	C_{ab}		
6.14	Recharge behaviour	24 h	168 h			
Product durability in service		**IEC 60896-21 test clause result**				
6.15	Float service life at 40 °C	Days with C_3 rate test at 40 °C				
6.16	Impact of stress temperature of 55 °C or 60 °C	Days with C_3 rate test at 55 °C or 60 °C Days with $C_{0.25}$ rate test at 55 °C or 60 °C				
6.17	Abusive over-discharge					
6.18	Thermal runaway sensitivity					
6.19	Low temperature sensitivity					
6.20	Dimensional stability at elevated internal pressure and temperature					
6.21	Stability against mechanical abuse of units during installation					
Company name: Company officer: Address/phone/fax/e-mail: Signature/date/place: Document established as reply for RFI:						

NOTE The data in above Product Range Test Result Supplier Statement must comply with the test methods and degree of detail specified in the requirements 6.1 to 6.21 of the IEC 60896-21 and IEC 60896-22.

Figure 3. The ANNEX A and B for a structured information exchange in the framework of the use of EN/IEC 60896-22.

VRLA test compliance declaration as per EN/IEC 60896-22

A key tenet of the handling of the EN/IEC 60896-21 and –22 is the fact that no statement "*this cell or monobloc is compliant with EN/IEC 60896-21 or -22*" is admissible. Any link between the Standard and a particular VRLA battery or battery range has to be preferably formulated in wordings such as "*The cell ABC (or monobloc), representative of the product range XYZ, has been tested according to EN/IEC 60896-21 Clause 1 to 21, and the test results indicate compliance with EN/IEC 60896-22, clause 6.2, 6.4 to 6.8, 6.11 to 6.12, 6.14, 6.18 and 6.21. For the remaining clauses, the test results are at or above the minima specified and can be provided to interested parties.*"

Selected requirements and actual compliance data values

Some selected requirements and typical values achieved are listed below

Clause 6.2	High current tolerance Show ≥2.0Vpc and no evidence of incipient melting or loss of electrical continuity after 30 seconds current flow	12V FA monobloc 1275A – 30s No damage
Clause 6.4	Protection against internal ignition from external spark sources No evidence of rapid combustion or explosion beyond valve/barrier assemblies	Valves with flame barrier No internal combustion or fire
Clause 6.9	Flammability rating of materials State the rating level for samples of thickness equivalent to that of case and cover	Rating of FV0 or HB at 5mm when tested with IEC 60707 and IEC 60695-11-10
Clause 6.11	Discharge capacity C_a to be at least 95% of C_{rt} with all units at all rates from 0.25h to 10h to specified voltages	C_a with dry-charged units >98-103% C_a with in-situ formed units >92-97%
Clause 6.13	Float service with daily discharges Number of 2h discharges before reaching 1.80Vpc 50 cycles – 150 cycles – 300 cycles depending on grid reliability	~ 120-300 cycles thin to medium thick plate ~ 400 – 800 cycles optimized designs C_{af} and C_{ab} - no additional cycles achieved
Clause 6.14	Recharge behavior 24h Recharge behavior factor $Rbf_{24h} \geq 90\%$ 168h Recharge behavior factor $Rbf_{168h} \geq 98\%$	Rbf_{24h} 90-92% Rbf_{168h} 95-96%
Clause 6.15	Service life at an operating temperature of 40°C Days on float168h to a capacity of ≤ 80% of rated 3h ≥500d – ≥750d – ≥1100d – ≥1700d	12V FA designs >750d 6V bloc design >900 to 1440d 2V single cell design >>1100d
Clause 6.17	Abusive over-discharges Unbalanced string - capacity recovery to ≥ 80% (C_{aod}) Cyclic overdischarge - capacity remaining ≥ 90% (C_{aoc})	$C_{aod} \geq 73\%$ $C_{aoc} \geq 97\%$ to 108%
Clause 6.18	Thermal runaway sensitivity 1 week below 60°C at 2.45Vpc and/or final temperature Time to 60°C at 2.60Vpc	12V 50Ah FA 1 week - 45°C / 58h - 60°C 6V 200Ah 1 week - 37°C / 33h - 60°C 2V 1600Ah 1 week - 33°C / 168h - 38°
Clause 6.19	Low temperature sensitivity $C_{als} \geq 0.95$ after recharge from a full 10h discharge and freezing at –18°C	C_{als} 1.05 to 1.10
Clause 6.21	Stability against mechanical abuse of units during installation Double corner and edge drop test - no damage (cracks etc) Weight dependent drop height	Drop heights 100m to 25mm No damages with ABS and ABS-PC

SUMMARY AND CONCLUSIONS

The Technical Commission 21 of IEC, responsible for Secondary Cells and Batteries, has prepared and published, in March 2004, two IEC Standards defining Test Methods and Requirements for Stationary VRLA cells and monoblocs. This internationally applicable document is destined to be used to specify VRLA batteries and compare their actual performances when supplied from sources worldwide.

The characteristics verification covers aspects of Safe Operation, Performance and Durability and is laid down in 21 clauses.

The requirements or desirable test outcomes for each clause reflect the consensus of experts from battery manufacturers and battery users and the understanding that VRLA cells and monoblocs should always allow a Safe Operation, but that Performance and Durability needs should/could be modulated in function of the operating conditions so to minimize costs.

A template for the transmittal of specific requirements to the manufacturer and a template for the communication of test results to the user are included in Standard EN/IEC 60896-22.

As with any standard, the advantages and simplifications achievable in the procurement of such batteries can only be realized if the battery manufacturers and battery users work hand in hand when testing and when specifying them and use the EN/IEC 60896-21 and -22 Standard as the platform for their business dealings.

ACKNOWLEDGEMENTS

Mark Kniveton and the author thank the representatives of the following companies for their support and for contributions in the writing of these two standards.

Alcatel, Avansys, BAE, British Telecom, C&D, Deutsche Telekom, EDF-Emerson, Enersys, Exide, Fiamm, France Telecom, Gertek, GNB, Hoppecke, Lucent, MGE, Nokia, Oerlikon, Siemens, Swisscom, Telepower, and YUASA.