UPS VRLA BATTERY SPECIFICATION GUIDE

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The battery industry is still struggling to educate the user/purchaser of the capabilities and limitations of the various grades of VRLA batteries. By definition, an Uninterruptible Power System (UPS) is supposed to provide a constant source of power, and the battery that is purchased with the unit is expected to be infallible. We know that this is not the case, and users are now realizing that the battery is critical, and frequently the weak link, in assuring continuous power to their critical loads. They frequently depend entirely on the UPS manufacturer to furnish the proper battery to live up to the claim that their system is a constant source of power. Usually, the only stated requirement to the manufacturer is for a battery that lasts "X" minutes under full load, and that it be "Maintenance Free". In the highly competitive UPS market, the common method of winning the bid for the system is to offer the cheapest battery available that meets the battery specification. Consequently, with a very weak battery specification, most of the UPS systems receive a low grade of battery that frequently does not meet expectations.

The users and consultants need a purchase/construction specification that will provide quantifiable limitations to achieve a desired quality standard. Not all applications require the highest level of quality, or can justify the expense of the best possible system. Therefore, a specification needs to be flexible in distinguishing the particulars needed to satisfy the requirements for the application or applications in question. I have chosen to break the grades of batteries into three groups, and refer to these in an application sense as, 1.) "Low Criticality", 2.) "Medium Criticality", and 3.) "High Criticality". Those UPS applications that would have extremely high cost or business impacts on the loss of power, would specify the "high criticality" level of battery. These batteries cost significantly more, but provide a high level of "protection". The lesser impacts of power loss could select a lower level of battery specification. The "UPS VRLA Battery Specification Guide" attempts to quantify some of the key parameters that will allow a user to distinguish between the various grades of battery, while providing enough detail to prevent the purchase of an inferior grade of battery for even the "low criticality" applications.

It is important to note that in the planning process for a UPS installation, space allocations are frequently made well before the specification of the battery, with most projects never considering anything other than the standard manufacturer's dimensional literature for battery cabinets. These dimensions are based on the standard offering of a commercially competitive grade of battery, however, if a higher grade of battery is to be specified, the dimensions will probably increase. Discussions with the manufacturers are critical to attain the correct cabinet sizes based on the specified batteries.

This specification guide also requires that a final capacity test be performed on site, following the completed installation. This conflicts with some industry recommendations, but I feel it is most critical to test the battery in its final installed state to assure that all intercell connectors and cables have been torqued properly, that no batteries have been damaged in transit, and that the system will perform as specified and designed. The factory testing provides proof of the design, but not the installation.

The main point of this proposed specification guide is to require that the contractor provide a quality product that meets your requirements, not just the most competitive product available. The UPS and battery manufacturers should welcome a specification that allows fair competition for a battery that will meet the customers needs, and allow them to meet these needs with an appropriate product. If you choose not to use this specification guide, please develop your own battery specification that assures your application requirements are met.

Acknowledgement:

I would like to thank Thomas E. Ruhlmann, Johnson Controls Battery Group for allowing the use of his paper, "Ameribat Part I", to gain the technical requirements for a good generic battery. In starting out on this endeavor, I did not realize the difficulty I would encounter in trying to find the distinguishing factors that make a high-grade battery better than a lower grade battery, while avoiding being manufacturer specific. Tom's paper gave me the basic parameters of a quality battery in any grade that were a great help in making this specification guide something that should give the users a reliable product.

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Notes to specifier:

1.) Certain items require a choice of parameters based on the intended use (criticality) of the application. Paragraphs and items throughout this specification guide that require a choice of battery grade will be keyed to the "Low", "Medium", and "High" degrees of criticality, as defined below. Appropriate paragraphs are identified in front of the selection to be made.

Symbol	Intended Application	Battery Type	Design Life
(L)	**Low Criticality**	High Rate	5 to 8 year
(M)	**Medium Criticality**	High Rate Long Life	10 year
(H)	**High Criticality**	High Rate Premium	10+ year (20 yr.)

2.) Fill in the blanks throughout the specification guide with the desired parameters.

3.) On systems requiring full load and specified time period over the life of the battery, the specifier should include a statement that the battery will be designed to allow a 125% capacity "aging factor" to account for the 80% loss of capacity near the battery's end of life.

4.) The specifier may need to delete paragraphs or sections of the specification for certain applications.

Definitions:

Valve Regulated Lead Acid (VRLA) Battery - A lead acid battery with an immobilized electrolyte that is sealed in terms of electrolyte maintenance. The battery contains a pressure relief valve that releases excessive internal pressure to the atmosphere when the cell pressure exceeds a manufacturer's prescribed level. The immobilizing electrolyte medium accommodates an oxygen recombination cycle thus minimizing gassing and water consumption.

Design Life - The number of years (or cycles) of service for which a battery is designed assuming optimum manufacturing materials and processes and optimum distribution, installation and operating conditions.

Life Expectancy - That estimated life attained by sample batteries when subjected to accelerated life test conditions.

Service Life - That life actually attained in service under actual operating conditions for which the battery was designed.

Block - An individual unit consisting of one or more cells.

Mono-cell - A block consisting of only one cell.

Multi-cell - A block consisting of 2 or more cells; typically 2, 3, 4, or 6.

RELEVANT STANDARDS AND SPECIFICATIONS

UL-924	Emergency Power and Lighting Equipment
UL-1989	Standby Batteries (ISBN 0-7629-0078-4)
UL-1778	Uninterruptible Power Supply Equipment
NEC Section 480	Storage Batteries
NEMA IB-4	Determination of Ampere-hour and Watt-hour Capacity of Lead- Acid Industrial Storage Batteries for Stationary Service (vented cells)
NEMA IB-7	Testing Flame Arrestor Vents Used on Lead-Acid Industrial Storage Batteries for Stationary Service (vented cells)
IEEE 1189	Guide for Selection of Valve Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
IEEE 1187	Recommended Practice for Installation Design and Installation of Valve Regulated Lead-Acid Batteries for Stationary Applications
IEEE1188	Recommended Practice for Maintenance, Testing and Replacement of Valve Regulated Lead-Acid (VRLA) Batteries for Stationary Applications

1.Validation Requirements

The validation of specific criteria throughout this specification shall available upon request from the manufacturer in the form of design criteria, certification of testing by the manufacturer, documented experience base of the product in the field, or accelerated life testing of equal or less robust systems.

2. VRLA Battery Application and Life Categories

The battery manufacturer shall identify their battery by the relevant float service design life category (design life) as indicated below. In addition, the number of 3-hour rate cycles that can be delivered when continuously cycled shall be indicated. This is the maximum life that could be expected for an individual block when manufactured and utilized under optimal conditions.

Battery Type	Design Life
High Rate -	5 to 8 year design life
High Rate Long Life -	10 year design life
High Rate Premium -	10+ year (20 yr.) design life

3. VRLA Battery Characteristics

(L) 3.1 The VRLA battery shall be Absorbed Glass Mat (AGM) construction, rated for ___ minutes discharge to 1.67 volts per cell. The battery shall be of the 5 to 8 year design life construction.

(M) 3.1 The VRLA battery shall be Absorbed Glass Mat (AGM) construction, rated for ___ minutes discharge to 1.72 *(or 1.75)* volts per cell. The battery shall be of the 10-year design life construction. The battery shall be configured as a parallel string to reduce the chance of a single cell failure taking down the entire battery.

(H) 3.1 The VRLA battery shall be Absorbed Glass Mat (AGM) construction, rated for ___ minutes discharge to 1.75 volts per cell. The battery shall be of the 10+ year (20 yr.) design life construction. The battery shall be configured as a parallel string to reduce the chance of a single cell failure taking down the entire battery.

3.2 Labeling - An acid resistant label shall be applied to the exterior of the battery in a location that is obvious to a viewer in typical installations and which includes, as a minimum, the following information written in English:

Battery Model / Part No.

Battery Nominal Voltage

Battery Rated Capacity and rating conditions

Battery average charging voltage range per cell or block and related charging conditions

Appropriate recycling information - may be internationally recognized symbols

Appropriate safety information - may include internationally recognized symbols

Battery terminal polarity markings either in English or as + and - symbols located in the immediate area of the related terminal. Polarity markings may be embossed or molded in the container.

3.3 Construction

3.3.1 Containers -

3.3.1.1 Material - The battery container (including cover) must be durable for handling, structurally rigid, electrically insulative, and of sufficient thickness to render gas permeability a non-issue. Acceptable materials include SAN, ABS, PVC, polycarbonate and polypropylene. In certain applications, the containers must be flame retardant with a minimum oxygen index factor of 28 and a V rating of 0, 1, or 2.

3.3.1.2 Rigidity - Container end walls shall be sufficiently rigid to minimize bowing under vent release pressure at 25°C and shall not exceed 3/16 " per end (3/8" overall).

3.3.2 Case to Cover Seal - The cover may be either bonded or welded to the container and shall be capable of remaining gas and electrolyte tight throughout the life of the battery. The assembly, including the terminal seal, shall be capable of withstanding 5 times the maximum vent operating pressure at 40°C without leakage.

3.3.3 Terminals

The block shall have "flag", "L", threaded stud, or threaded insert terminations. The terminals shall be sufficiently robust to withstand a short circuit connection for at least one-minute without damage. Density of terminations made of lead shall be such that re-torquing is not required more than once per year. Threaded terminations shall be capable of withstanding twice the recommended torque value without damage.

3.3.4 Terminal Seals

The terminal to cover seal shall remain gas and electrolyte tight when the battery is subjected to a 1 minute short circuit. The terminal to cover seal shall remain gas and electrolyte tight for the design life of the product under normal operating conditions throughout the products operating temperature range.

3.3.5 Intercell Connections

The intercell connections shall be sufficiently robust to withstand a 1 minute short circuit condition without damage to either the connection or the container and cover assembly.

4. Performance

4.1 Rated Capacity

High Rate Batteries shall be rated in watts per cell at the 15-minute discharge rate to 1.67 volts per cell at 25°C.

4.2 Achievement of Rated Capacity

High Rate batteries shall have a minimum capacity of *(H or M)* 95% *(L)* 90% of rating on first discharge following proper preparation and shall develop to 100 % within *(H or M)* 3 *(L)* 5 cycles. *(H or M only)* A system of 4 or more blocks shall provide 100% of rated capacity on the first discharge following proper preparation.

(H or M only) 4.3 Rated Cycle Life

The cycle life of batteries used in float service shall be identified. This shall be the cycle life attained to 80% of rated capacity at the 3 hour discharge rate to 1.75 volts per cell.

4.4 Storage Life

The block shall have a self discharge rate of no more than 5% per month at 25°C and shall be capable of being restored to full rated capacity after 6 months storage at 25°C utilizing the manufacturers recommended "freshening" charge practices.

4.5 Ripple Current Tolerance

The battery shall be able to withstand up to 5 amperes per 100 ampere-hours rated capacity (at the 20 hour rate) without significant heating (less than 1°C) or degradation in the expected life.

4.6 Thermal Runaway Resistance

The battery shall be capable of withstanding the following conditions without entering thermal runaway:

2.4 volts per cell charging voltage at 40°C	Indefinite
2.45 volts per cell charging voltage at 40°C	168 hours
2.5 volts per cell charging voltage at 40°C	72 hours

5. Battery Cabinet

5.1 The battery cabinet shall be sized with adequate space between shelves to allow maintenance and test measurement access. Increased clearance is required for multiple rows of batteries behind the front row in the cabinet. Batteries on pull out drawers are encouraged for safety and maintenance access. *(Specifier may desire to specify pull out drawers as a requirement.)*

6. On-Site Testing

6.1 A factory test is acceptable to verify rated capacity of the system as required in paragraph 4.2. A full - rated capacity test at 100% load rating to the prescribed voltage discharge level shall be performed on site by the manufacturer's representative after the installation is completed to verify adequate installation techniques and ratings in final configuration. Multi-cell battery block temperatures shall be taken during this load test to verify that adjacent blocks remain within 1°C of each other. During the capacity discharge test, individual battery performance measurements shall be taken at the battery, not just combined readings at the UPS.

6.2 As part of on-site testing, intercell connector resistances and internal cell (block) resistances will be taken and documented.

7. Safety

7.1 Short Circuit Conditions

The battery shall be able to withstand a hard short circuit condition of indefinite duration without explosion or rupture.

7.2 Spark Arresting Vent System

When claimed to have a flame/spark arresting vent system, the venting system shall be designed to prevent direct entry into the cell of ignition sources from the outside atmosphere which could result in an explosion within the cell.

7.3 Flame Retarding Container Materials

When so claimed, the entire container system, including vents, shall be made of a flame retarding material having an oxygen index factor exceeding 28, and shall be classified as being a V0, V1 or V2 material.

8. Product Published Information

As a minimum, the following information shall be published concerning the product characteristics and application.

8.1 Product Mechanical Characteristics & Specifications

Dimensions, weight, terminal type and dimensions, and terminal hardware type and torquing values

8.2 Product Electrical Characteristics and Specifications

Nominal voltage, open circuit voltage when fully charged, short circuit current, internal resistance at DC or specified frequency, and recommended maximum AC ripple voltage and current

8.3 Product Electrical Discharge Characteristics and Specifications

8.3.1 Rated ampere-hour capacity to 1.75 volts per cell at 25°C for the 8, 10, or 20-hour discharge rates.

8.3.2 Constant power discharge rate for the 5, 10,15, 30, 40, 60, and 90-minute periods to 1.67 and 1.75 volts per cell at 25°C.

8.4 Product Charging Electrical Characteristics and Specifications

8.4.1 Recommended float-charging voltage at 25°C.

8.4.2 Recommended float-charging voltage temperature compensation factor.

8.4.3 Recommended equalization (freshening) charge voltage at 25°C.

8.4.4 Recommended charging current limit for intended application

8.4.5 Recommended Maximum allowable AC ripple voltage and current on the DC charging voltage and current.

8.5 Safety Considerations

Type and specific gravity of the electrolyte

Short circuit current

Any warnings directly related to use of the product