Eskom	Standard	Technology

Title: **STATIONARY VENTED LEAD ACID BATTERIES STANDARD**

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Content

Tables

1. Introduction

This standard contains information regarding the technical requirements of Stationary Vented Lead Acid Batteries, accessories and ancillary equipment.

2. Supporting clauses

2.1 Scope

This standard details the technical requirements with respect to the design, manufacture at works, testing, quality assurance, delivery to site, off-loading, erection, commissioning, decommissioning and disposal of vented / flooded lead acid cells and its ancillary equipment.

2.1.1 Purpose

The document addresses the standard documented technical specifications to be used when evaluating Stationary Vented Lead Acid Batteries during tender submissions in line with the Eskom Holdings SOC (Ltd) requirements.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] IEEE Std 485: IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications

[3] SANS 60896-11: Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test

[4] SANS 10108, The Classification of Hazardous Locations and the Selection of Apparatus for use in such locations

[5] SANS 10119, Reduction of Explosion Hazards Presented by Electrical Equipment – Segregation. Ventilation and Pressurization

[6] 240-56227923 Battery Quality Requirements

[7] 240-56356510 Definitions of Terms Applicable to DC Emergency Supplies standard

[8] 240-53114248 Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies

[9] D-DT-9213 Hydrometer Lead Acid Batteries D9213

[10] D-DT-9214 Thermometer Lead Acid Batteries D9214

2.2.2 Informative

[11] 240-137465740, Standby battery storage and commissioning in Eskom

[12] 240-61182045, Maintenance engineering standard for batteries and chargers

[13] 240-118705836, Maintenance of Batteries

[14] 240-56176168 DC systems setting standard

[15] 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte.

[16] 240-56227923, Quality Requirements for Stationary Vented Nickel Cadmium and Lead Acid Batteries for Power Stations Specification

[17] 240-56177186, Battery room standard

[18] 240-56176852, Essential Power Supplies for Power Stations Standard

[19] 240-118870219, Standby power systems topology and autonomy for Eskom

[20] 240-56362221, Standard for safety signs used in DC applications

[21] 240-44175132 Eskom Personal Protective Equipment (PPE)

2.3 Definitions

2.3.1 General

The definitions of SANS 60896-11: 2003, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply in addition to the following:

Definition	Description
Brace	A support forming the hypotenuse of a right angled triangle, with the vertical leg and the horizontal runner forming the other two sides.
Commissioning	The activity of putting plant into service.
Dry charged	Cells that are without electrolyte and of which the plates (electrodes) are in the charged state. These cells need to be filled with electrolyte and initial charged to form the plates.
Erection	The activity of installing the plant.
Hydrometer	An instrument used for measuring the relative density of a liquid.
Initial charging	A current controlled charge to ensure that the cell plates are properly formed.
Kt Factor	The ratio of rated ampere-hour capacity [at a standard time rate, at 25 °C (77 °F) and to a standard minimum cell voltage] of a cell, to the amperes that can be supplied by that cell for t minutes at 25 °C (77 °F) and to a given minimum cell voltage [2].
Rated capacity	Quantity of electricity C_{10}Ah (ampere hours), declared by the manufacturer, which a fully charged single cell can deliver to a specified end-of-discharge terminal voltage during a 10h discharge period at a specified electrolyte temperature.
Runners	The top horizontal beams that run parallel to one another along the length of the stand.
Transverse support beams (struts)	The horizontal beams that run parallel to one another and perpendicular to the length of the stand.
Wet charged	Cells that are charged, filled with electrolyte and which have already received their initial charge to form the plates.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AC	Alternating Current
Ah	Ampere hour
C_{10}	10 hour rated capacity
DC	Direct Current
OEM	Original Equipment Manufacturer
RMS	Root Mean Square
SANS	South African National Standards
SG	Specific Gravity

2.5 Roles and responsibilities

Parties that need to procure vented, lead acid cells shall use the latest revision of this document.

2.6 Process for monitoring

The Batteries Care Group of the DC & Auxiliary Supplies Study Committee shall ensure that document is always maintained and updated.

2.7 Related/supporting documents

Section 3.5.1.12 of this document replaces the contents related to Vented Lead Acid battery logbooks in 240-76627823, Lead Acid and Nickel Cadmium Battery Logbooks Standard.

3. Stationary vented lead acid batteries standard

3.1 General Requirements

Unless otherwise specified, the following are required:

a) The scope shall be for the manufacture, delivery to site, off-loading, erection, commissioning and de-commissioning of vented lead acid cells to Eskom stores or sites.

b) The tender shall state which of the following cells shall be part of the scope:

1) Flat plate (Fauré X) single (2 V nominal)

2) Planté plate single (2 V nominal)

3) Tubular plate single (2 V nominal)

c) The cells shall be supplied either in the dry charged, or wet charged state, which shall be indicated by individual orders.

d) Wet charged cells shall be initial charged and capacity tested by the manufacturer / supplier at his works and may be witnessed by an Eskom representative, before being transported to the required destination. The full initial charge and automated capacity test documentation shall also be supplied with each consignment.

e) Automated test results are to include the following data.

1) Cell voltages logged date and time stamped.

2) Battery bank voltage with discharge current logged for the duration of the discharge test.

3) These results shall be supplied in the original (native) data logging reporting format.

4) To be supplied in hard copy but also be available in electronic format.

f) In the case of the supply of dry charged cells – During initial charging at site or workshop an automated capacity test shall be done to verify the integrity of the battery. Again a full set of initial charge and automated discharge test result documentation shall be required. This can be done internal by Eskom or by the contract supplier.

g) All cells shall be supplied complete with all necessary inter-cell connectors, nuts, bolts, washers, anti-corrosion lubricant, cell numbers. In the case of dry charged cells, the electrolyte shall also be supplied.

h) When required the supplier shall also be responsible for the provision of maintenance equipment, safety equipment, battery stands, terminating devices and inter-row connectors, transportation and disposal of redundant cells, of which the requirements shall be stated later.

i) Direct communication access between Eskom and the OEM shall be catered for on technical issues. The contact details to be provided as part of tender information.

j) The OEM acknowledgement of certification / accreditation for the supplier should contain in detail:

1) Formal Distribution agreement/appointment, should include duration and scope of contract,

2) Technical support offered,

3) Warranties offered via OEM directly to Eskom,

4) These agreements/contract on formal OEM authorised document.

3.2 Electrical performance requirements

3.2.1 General

The essential characteristic of a stationary cell or battery is its capacity for the storage of electric energy. This capacity, expressed in ampere-hours (Ah), varies depending on the conditions of use, which means that it is affected by the discharge rate, electrolyte temperature and end-of-discharge voltage.

3.2.2 Rated Capacity

3.2.2.1 The rated capacity, C_{rt}, of a cell is a reference value, indicated by the manufacturer, which is valid for a new cell or battery at the reference temperature over a specified discharge period, t, to a specified end-of-discharge (final) voltage, U_f. The requirements of clause 7 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply.

3.2.2.2 The rated capacities (C_{rt}) shall be specified at a reference temperature of 25°C, over a discharge period of 10h to a final end-of-discharge voltage of 1,80V/cell.

3.2.2.3 The tenderer shall specify the rated offered capacity that is equal to or greater than the required rated capacities with Range 1 been 50 – 700Ah in 50Ah increments and Range 2 been 700 – 2200Ah in 100Ah increments. This shall be listed on the Schedule B of the Technical Schedule – Annex A.

3.2.3 Discharge tables and capacity rating factors

3.2.3.1 The tenderer shall submit discharge tables that indicate the discharge performance for offered cells at a reference temperature of 25°C, to the end-of-discharge voltages of 1,60V/cell, 1,70V/cell, 1,75V/cell 1,80V/cell and 1,85V/cell, over the following discharge periods:

1s, 1min, 2min, 10min, 1h, 2h, 3h, 4h, 6h, 8h, 10h, 12h, 16h, 18h, 24h, 32h and 240h.

3.2.3.2 The tenderer shall submit the K_t factors (capacity rating factors) for the offered cells with C_{rt} as specified in 3.2.2.2. The K_t factors shall be tabulated for the same end-of-discharge voltages and discharge periods as specified in 3.2.3.1.

3.2.4 Suitability for floating operation

3.2.4.1 The manufacturer shall state the specified upper and lower limits of specific gravity (SG) and voltage per cell in the fully charged floating state.

3.2.4.2 The manufacturer shall state the recommended boost charge voltage range as well as the recommended frequency of boost charging or under what conditions boost charging is recommended.

3.2.4.3 The manufacturer shall state the recommended equalise charge voltage range as well as the recommended frequency of equalise charging or under what conditions equalise charging is recommended.

3.2.4.4 The manufacturer shall proof, in accordance with clause 8.2 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test that after a period of six months of float operation the actual capacity, C_a, is at least equal to, C_{rt}, after discharge testing in accordance with clause 14 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test.

3.2.5 Endurance

3.2.5.1 The requirements of clause 9 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply.

3.2.5.2 The minimum expected life of the cell or battery shall be as indicated below under the conditions as specified in 3.4.1:

1) Flat plate (Fauré X) single (2 V nominal) : 15 years

2) Planté plate single (2 V nominal) : 20 years

3) Tubular plate single (2 V nominal) : 12 years

3.2.5.3 The expected end-of-life capacity shall be not less than $0{,}8C_{10}$ for flat plate and tubular cells. For Planté cells the end-of-life capacity shall be C_{10} for the expected life.

3.2.5.4 The manufacturer shall state the expected rate of deterioration over the cell or battery's life under the conditions as specified in 3.4.1. This shall be stated as expected capacity loss per year, [Ah/yr].

3.2.5.5 The manufacturer shall state the number of cycles to $C_a = 0{,}8C_{10}$.

3.2.5.6 The manufacturer shall state the number of cycles until end-of-life for Planté cells.

3.2.5.7 The endurance in overcharge shall be tested according to clause 17 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test.

3.2.6 Charge retention

The requirements of clause 10 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply. The manufacturer shall state the obtained charge retention, CR, as a percentage of the initial capacity, C_a.

3.2.7 Short-circuit current and internal resistance

3.2.7.1 The requirements of clauses 11 and 19 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply.

3.2.7.2 The manufacturer shall state the value of the short-circuit current, I_{sc} in amperes [A].

3.2.7.3 The manufacturer shall state the value of the internal resistance, R_i in ohms [Ω], at the reference temperature of 25°C and at the values of SG and voltage for a fully charged cell, as stated in 3.2.4.1.

3.2.8 Tolerance to AC components of the DC supply

3.2.8.1 The manufacturer shall state the maximum allowable ripple current and the effect thereof on expected battery life.

3.2.8.2 If the actual ripple current is more than 5%C_{10} during float charge and 20%C_{10} during boost charge or equalise charge, the value of the ripple current shall be specified by the purchaser and the manufacturer shall state the effect on expected battery life.

3.2.8.3 Where available, Eskom shall specify the value of the RMS ripple current and / or voltage in schedule A and the manufacturer shall indicate the effect on expected battery life in schedule B. If not indicated in schedule A the ripple values indicated in standard, 240-53114248 Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies, shall be applicable.

3.2.9 Effect of temperature

3.2.9.1 The manufacturer shall indicate, in schedule B, the effects of temperature on the expected battery life.

3.2.9.2 The manufacturer shall also indicate, in table format or on a graph, the effects of temperature on the available capacity for the temperature range of -10°C to +45°C. Temperature de-rating factors shall be indicated.

3.3 Mechanical requirements

3.3.1 General

3.3.1.1 The offered cells shall be of the vented type in which the electrolyte is diluted sulphuric acid. The cells shall be fitted with plates in which the active materials on the positive and negative electrodes are lead dioxide (PbO_2) and spongy lead (Pb), respectively.

3.3.1.2 The stationary cells shall be designed to withstand mechanical stresses during normal transportation and handling.

3.3.1.3 Resistance to earthquakes, if required, shall be particularly specified by in Schedule A.

3.3.2 Plates

3.3.2.1 The positive plates shall be of the pasted, open-grid type for the flat plate cells, tubular types for the tubular cells and Planté type for the Planté cells. The negative plates shall be of the pasted open-grid type.

3.3.2.2 The manufacturer shall specify the type of lead alloy used (e.g. lead-calcium or lead-antimony) and also the amount (%) of foreign material present.

3.3.2.3 The plates shall be designed to minimise sedimentation, loss of active material, distortion and buckling.

3.3.3 Separators

3.3.3.1 Separators shall be made of a micro porous material which is chemically inert and offers minimal internal resistance.

3.3.3.2 The expected life of the separators shall be at least equal to the expected life of the cells as specified in 3.2.5.2.

3.3.4 Group bars

Group bars shall be made of lead or a lead alloy which is compatible with the grid material.

3.3.5 Terminal posts

3.3.5.1 The terminal posts shall be cast in a lead alloy which is compatible with the grid material and group bars.

3.3.5.2 The casted terminal posts shall have a smooth surface finish, free from porosity (preventing any capillary action) and other defects.

3.3.5.3 The terminal posts shall be designed to give minimum resistance and provide maximum current flow.

3.3.5.4 The terminal posts shall be compatible with the electrochemical conditions within the cell and shall be suitable for mechanical connections. The manufacturer shall state the recommended torque levels for the connections.

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

3.3.6 Terminal seals

The terminal seals shall fit firmly around the terminal posts to prevent any form of electrolyte creepage or leakage between the terminal post and the cell lid. The seal shall thus be designed to prevent corrosion of the terminal post above the cell lid.

3.3.7 Containers

3.3.7.1 The containers shall be made of a plastics material which is translucent and free from bubbles.

3.3.7.2 The minimum and maximum levels shall be indicated on the container wall.

3.3.7.3 When resting on a level surface, the containers shall stand firmly and their top surfaces shall be horizontal.

3.3.7.4 The injection moulding end point shall be recessed in such a way that it shall not endure any mechanical stress (pressure) when the cell is filled with electrolyte as this can lead to the formation of leaks.

3.3.8 Cell lids

3.3.8.1 The cell lids shall be sealed to the container and the sealant / glue used shall prevent any electrolyte leaks at the lid-container seam.

3.3.8.2 The complete cell shall be sufficiently sealed to handle the internal pressure during normal operation.

3.3.9 Vent plugs

3.3.9.1 The filler / vent plugs shall be readily removable, and so located to permit the easy topping-up of cells, where applicable.

3.3.9.2 The plugs shall be designed so that the free escape of gases from the cells is permitted, but also that electrolyte spray is trapped and returned to the cells.

3.3.10 Gas recombination units

3.3.10.1 The manufacturer shall state the optional hydrogen and oxygen gas recombination unit for his product.

3.3.10.2 The manufacturer shall indicate the life expectancy of the catalyst inside the gas recombination unit. A formula or graph that takes into account voltage and ambient temperature must be supplied.

3.3.10.3 The manufacturer shall supply the catalyst material data sheet as part of the tender.

3.3.10.4 The gas recombination unit must prevent contamination of the lead acid cell and at least last the expected lifetime of the cell under the specified operating conditions.

3.3.10.5 The manufacturer shall supply a list of approved third party gas recombination units to be used on the offered lead acid cells.

3.3.11 Hydrogen release

3.3.11.1 The expected volume of hydrogen release, at an electrolyte temperature of 25°C, for each of the charging regimes in 3.4.3 shall be supplied.

3.3.11.2 The expected volume of hydrogen release, at an electrolyte temperature of 25°C, for cells equipped with and without the recombination units shall be supplied at the maximum elevated voltages as stipulated in SANS 10108, The Classification of Hazardous Locations and the Selection of Apparatus for use in such locations.

3.3.12 Electrolyte reserve

3.3.12.1 The manufacturer shall proof, in accordance with clause 8.2 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, that after a period of six months of float operation the loss of electrolyte shall not exceed 50% of the volume between the minimum and maximum levels. The volumes between minimum and maximum shall be submitted with the tender documentation.

3.3.12.2 The electrolyte reserve shall be sufficient to ensure that the electrolyte level shall not fall below the minimum mark within a minimum period of 6 months under the conditions as specified in 3.4.1 and charging regimes as specified in 3.4.3. If the actual period under stated conditions is in excess of 6 months, then the manufacturer shall state that period.

3.3.12.3 The improved topping up period that can be expected with the fitment of the recommended recombination units shall be specified by the manufacturer under the conditions as specified in 3.4.1 and charging regimes as specified in 3.4.3.

3.3.13 Containment of shedded active material

The cell shall be designed to ensure that sufficient space is allowed for below the plate ends, at the bottom of the cell container, for the safe containment (e.g. not causing short circuits) of shedded active material during the life of the cell.

3.3.14 Positive plate growth

The cells shall be designed in such a way that the expansion of positive plates, due to positive plate growth over the lifetime of the cell, shall not cause the cell lids to lift or crack.

3.3.15 Cell orientation

The two possible methods of mounting cells on the stands are:

3.3.15.1 face-to-face, i.e. with the face of the outer plates of each cell facing directly against the face of the outer plates of adjacent cells; and

3.3.15.2 edge-to-edge, i.e. with the edges of the plates of each cell facing the edges of the plates in the adjacent cells.

The default method of mounting is face-to-face, regardless of whether the cells are under-square or over-square. In cases where there are space constraints, the edge-to-edge method is acceptable. Cells shall be mounted with a minimum clearance of 100 mm between rows of cells on the same stand.

3.3.16 Cell marking and labelling

3.3.16.1 At least the positive terminal post on each cell shall be clearly and indelibly marked with its polarity. The marking shall take the form of +, indented or in relief, on the cell lid adjacent to the positive terminal. The symbols used for marking polarity shall be in accordance with clause 24.3 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test.

3.3.16.2 The minimum and maximum levels shall be clearly indicated on the container wall.

3.3.16.3 The following information shall be clearly and permanently marked on each cell:

1) the manufacturer's or supplier's name,

2) type code,

3) date of manufacture (month and year),

4) nominal voltage,

5) C_{10} capacity at the reference temperature,

6) reference temperature

7) the SG for a fully charged cell at the reference temperature

3.3.16.4 Information relevant to safety recommendations as required by local, national or international regulations shall be marked on each cell.

3.3.16.5 Cell numbers shall comply with the following requirements:

1) Each cell shall have a label indicating the number of the cell. These numbers shall run consecutively, commencing with the cell representing the positive terminal of the battery as number one.

2) Labels shall be of a non-conducting material that will be unaffected by the environment, and shall remain legible for the life of the battery.

3) The labels shall be legible from a distance of 2 m, (minimum size of 25 mm), and shall have black numbers on a white background, or white numbers on a black background.

4) The labels shall be affixed to the cells, or to the corresponding positions on the stands. The positioning of the labels shall be such that the visual inspection of plates and electrolyte levels shall not be impeded.

5) The adhesive used for the labels shall be unaffected by the environment, and shall hold the labels securely for the life of the battery.

3.3.16.6 When called for by the purchaser, individual cells shall be uniquely labelled with a barcode, of which the detail requirements shall be supplied by Eskom.

3.4 Operational requirements

3.4.1 Environmental conditions

3.4.1.1 The equipment covered by this specification shall be suitable for operation under the following conditions:

1)	altitude	:	2 200 metres maximum
2)	relative humidity	:	10% to 85% non condensing
3)	lightning	:	high lightning area
4)	pollution level	:	low to high with conductive particles when wet

3.4.1.2 Outdoor air temperatures

1)	maximum	:	45 °C
2)	daily average	:	35 °C
3)	yearly average	:	30 °C
4)	minimum	:	-10 °C

3.4.1.3 Battery room air temperatures

1)	maximum	:	40 °C
2)	daily average	:	30 °C
3)	yearly average	:	25 °C
4)	minimum	:	-5 °C

3.4.2 Application

The batteries are used in a stationary application for the supply of backup power during AC supply failure conditions at sites. The batteries are of the flooded type and are installed in separate battery rooms, normally on the coolest side of the building. Mainly planté plate cells are used at power generating plants, whereas flat plate cells are used at Distribution – and Transmission substations. Tubular plate cells are used at renewable sites.

The loads that are normally connected to the DC system include protection relays, spring rewind motors of switchgear, telecontrol equipment, telecommunications equipment, control and instrumentation equipment and emergency lights.

The main voltages and amount of cells normally used per battery bank are indicated in 1. The required standby times are specified.

Table 1: Guideline for number of cells per lead acid battery

Voltage [V]	Number of cells [1)]
12	6
24	12
36	18
50	24
110	52
220	104
Note: For systems with high or low voltage constraints, less or more cells may be used.	

In applications where the maximum required battery charging voltage are higher than the maximum input voltage limit of the load equipment, the load voltage is regulated to the required level by using load voltage regulation equipment while the batteries are still maintained at maximum charge.

3.4.3 Charging regimes

Three constant voltage, current limited, charging modes are used to ensure that the battery is optimally charged. Most of the battery's life is spent in the float charging mode, which is high enough to maintain a high level of available capacity, but also low enough to optimise the topping-up intervals.

The battery chargers are set to enter a higher voltage at predetermined times (usually every 28 days), termed the boost (autoboost) charging mode. This higher charging voltage causes the cells to gas which helps the electrolyte to mix and prevent stratification of the electrolyte. The battery chargers enter this charging mode also after an AC failure at the site to quickly regain lost charge, provided that the voltage fell below a specified trigger voltage.

During the equalise charge mode a higher voltage than that of the boost charge mode is applied to bring cells back into step, which means that an attempt is made to bring the voltages and SG's of individual cells as close as possible to the average values.

The recommended voltage settings are indicated in 240-53114248, Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies and 240-56176168, DC systems setting standard.

The manufacturer shall state if the proposed charging regimes and settings are accepted. If the former is not accepted, then alternative charging regimes and settings shall be recommended and submitted as part of the tender documentation.

3.4.4 Commissioning

3.4.4.1 Cells and batteries shall be commissioned in line with the requirements of 240-137465740, Standby battery storage and commissioning in Eskom. This document relates to the initial charge of the cells.

3.4.4.2 The manufacturer shall state, in schedule B, the acceptance of these conditions. If these conditions are not accepted, then the manufacturer shall include commissioning instructions as part of the tender documentation, indicating the differences with respect to the procedures as described in 240-137465740, Standby battery storage and commissioning in Eskom.

3.4.5 Maintenance

3.4.5.1 Cells and batteries shall be maintained in line with the requirements of 240-61182045, Maintenance engineering standard for Batteries and Chargers and 240-118705836, Maintenance of Batteries.

3.4.5.2 The manufacturer shall state, in schedule B, the acceptance of these conditions. If these conditions are not accepted, then the manufacturer shall include maintenance instructions as part of the tender documentation, indicating the differences with respect to the maintenance instructions as described in item 3.4.5.1.

3.4.5.3 The manufacturer shall further indicate the recommended maintenance activities indicating the minimum frequencies and level of maintenance required.

3.4.5.4 The manufacturer shall provide guidelines to what will be considered an out-of-step battery bank and the remedial actions required.

3.4.6 Battery water

3.4.6.1 The manufacturer shall state, in schedule B, the maximum conductivity of the recommended battery water to be used for topping-up purposes.

3.4.6.2 The manufacturer shall also include as part of the documentation, a list of other substances, with their allowable quantities, that are permitted to be present in the battery water.

3.4.7 Accessories

3.4.7.1 Cells shall be supplied complete with all required inter-cell connectors, nuts, bolts and washers (including flat and spring washers).

3.4.7.2 The material used for the bolts, nuts and washers shall be suitable for the application and ensure a reliable connection for the life of the equipment.

3.4.7.3 The bolts, nuts and washers shall be suitable for the connections and shall not deform or shear under the recommended torque levels.

3.4.8 Electrolyte

3.4.8.1 When the cells are to be supplied in the dry charged state, the electrolyte shall be supplied in 25 litres polycans. The cans shall be clearly labelled with the applicable hazardous substance signage and clear handling instructions in English.

3.4.8.2 These polycans shall be returned to the supplier once used and Eskom shall be refunded.

3.4.9 Terminating devices and inter-row connectors

When specified in schedule A, the manufacturer shall make terminating devices and inter-row connectors available which shall be suitable for use on the offered cells. Wall mounted - and stand mounted Terminating Devices shall be offered.

3.4.9.1 The terminating devices shall be flexible copper (welding cable). The ends of the terminating devices shall be colour coded in line with the polarity (blue for negative and red for positive). The supplier shall specify the length and cable size required for all the offered cells and the number of different terminating devices shall be optimised.

3.4.9.2 The inter-row connector's cables (coloured white) should be flexible copper similar to the terminating cables.

3.4.10 Equipment performance

The manufacturer shall submit a full track record which shall include the following:

1) Number of years that offered equipment has been in service;

2) Customers, indicating units employed, and their contact information;

3) Environmental conditions where such equipment are installed;

4) Known problems and / or exceptional performance with the installed units.

3.4.11 Type Test certificates, drawings and instruction manuals

When called for in schedule A, full comprehensive set of independent type test certificates with type test reports for all plate sizes in the offered range of cells shall be submitted with tender documentation. Any design changes in plates will require a new type test certification process.

3.4.11.1 The manufacturer shall include a table with the following parameters for the cells:

1) Cell type,

2) C_{10} rated capacity [Ah],

3) Amount of electrolyte at maximum mark [litres],

4) Dry weight mass [kg],

5) Wet weight mass [kg], and

6) Cell dimensions (length, width, height) [mm].

3.4.11.2 The following documents shall be supplied with each battery consignment:

1) A technical manual, which covers installation, commissioning, maintenance and safety instructions.

2) Initial charging test results, in the case of wet charged cells.

3) Clear storage instructions with the freshening charge information in cases of prolonged storage shall be supplied.

3.4.12 Tools

Any special keys and tools required for maintenance shall be supplied with the equipment.

3.4.13 Spares

3.4.13.1 The manufacturer shall provide a comprehensive list of spares to be held in stock that shall, at a minimum, include one of each of the different offered cells and consumable items, if any.

3.4.13.2 The spares items shall be priced individually and the lists shall include a description of the item, a reference number and the pricing details.

3.4.13.3 All spares shall be delivered in approved packaging suitable for storing such parts over a period of 5 years without damage or deterioration.

3.4.13.4 Spares shall be carried at the supplier's local works for the duration of the contract in accordance with the following numbers of cells in the field:

1) 1 to 1000 cells: 85 spare cells; and

2) 1001 cells and above: 107 spares of each cell type delivered.

3.4.13.5 The delivery time for these spares shall not exceed 24h ex-works from the receipt of an authorised written order from Eskom.

3.4.13.6 The manufacturer or manufacturer's agent shall keep spares at his premises in South Africa for a period of 5 years.

3.4.13.7 Spare cells and other items shall be available for a period of at least 10 years after contract expiry.

3.4.14 Training

When specified in schedule A, the supplier shall include proposals for specialised training in the use of the batteries for Eskom personnel. This training shall cover installation, commissioning and maintenance of the batteries. A recommended course structure, duration and price per course shall be provided with the tender. The price quoted shall assume that the supplier provides the venue, equipment and presenters. This course shall be presented to a core group of individuals of no more than 15 people. This course shall equip and accredited the Eskom people to present the course material as part of the DC Systems Commissioning Course presented in-house by Eskom – train-the-trainer type courses.

3.4.15 Warranty requirements

3.4.15.1 The manufacturer will be expected to provide a full OEM warranty of at least 2 years, and shall state clearly and unequivocally the conditions under which this warranty shall apply.

3.4.15.2 A second prorated warranty option shall be submitted. The prorated warranty shall be directly proportional to the obtained life from a cell versus the design life expectancy of the cell, clearly and unequivocally stating the conditions under which this warranty shall apply. Therefore if 50% of the design life expectancy was achieved Eskom will be liable for 50% of the cost on a new cell. The second warranty is related to the confidence level that a manufacturer has in the product.

3.4.15.3 The warranty offered shall be a warranty endorsed by the manufacturer (OEM) and not the manufacturer's representative.

3.4.15.4 The warranty offered by the OEM shall be in accordance to the expected environmental conditions as stipulated in this specification (in 3.4.1).

3.4.16 Local support

3.4.16.1 During the commissioning of a bank of cells, the manufacturer or agent shall provide a 24h response time to Eskom. The extent of the response shall, as a minimum, comprise:

1) Official notification of the problem being reported.

2) Suggested solution (provided in writing and recorded on the non-conformance / field-failure reporting system).

3) The replacement of faulty cells.

3.4.16.2 It is required that the manufacturer or representative has trained support staff available on a national basis.

3.4.17 Disposal

3.4.17.1 Processes shall be in place for the environmentally sound disposal of all used (redundant) cells and electrolyte. A copy of a disposal certificate stating compliance with this requirement shall be included as part of the tender documentation.

3.4.17.2 Any disposal of redundant cells and electrolyte shall be in line with Eskom disposal procedure, 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte.

3.4.17.3 Processes shall be in place to ensure the following:

1) Collection of redundant cells from the Eskom sites.

2) Collection of electrolyte from the Eskom sites.

3) Removal of redundant plant where the installation and / or commissioning is done by the supplier.

3.4.17.4 The contracted supplier shall always have the first right of refusal when Eskom has a load of redundant batteries for disposal. The transportation costs shall be offset against the scrap value of the redundant cells to be collected.

3.4.18 Equipment limitations

3.4.18.1 A statement regarding known limitations of the equipment shall be made available to Eskom.

3.5 Ancillary equipment

3.5.1 Maintenance equipment

When specified in schedule A, the following maintenance equipment, as per 240-118705836, Maintenance of Batteries shall be made available:

3.5.1.1 Jug – the jug shall be clear plastic with a volume of 2 l. The scale divisions shall be at least 100 ml and be indelibly marked (indented or in relief) on the surface.

3.5.1.2 Funnel – the funnel shall be clear plastic with a mouth opening of maximum 150 mm in diameter and a stem opening of 10 mm in diameter.

3.5.1.3 Anti-corrosion lubricant – at least 250 ml,

3.5.1.4 Battery stand touch-up paint shall be made available in volumes of 500 ml and 1 l.

3.5.1.5 Paint brush – 50 mm wide.

3.5.1.6 Pack of paper towels.

3.5.1.7 The following general requirements apply to the hydrometer and thermometer:

1) The hydrometers and thermometers shall be made of smooth, transparent glass that is free of bubbles, or other imperfections. The glass shall be of a type that will adequately resist the action of chemical reagents in which it is normally used and also have suitable thermal qualities to permit its use over the range of specified temperatures to which it may be subjected. The glass shall be thoroughly annealed before final adjustment and sealing.

2) The instruments shall be able to withstand the corrosive action of Sulphuric Acid (H_2SO_4) and Potassium Hydroxide (KOH).

3) Please note that the dimensions listed in this specification are minimum requirements. Deviations from these requirements will be reviewed, but are subject to Eskom's acceptance and approval.

4) All hydrometers and thermometers shall be checked against standard reference instruments to ensure that the required accuracy is met.

3.5.1.8 An electronic thermometer – gun type with infra-red sensing

3.5.1.9 The analogue thermometer shall comply with the following requirements:

1) The thermometer shall be made of glass and the substance used to indicate the temperature shall be blue or red alcohol. The use of mercury is not acceptable, because it is a metal that could cause short circuits if the thermometer would break whilst inside the cell.

2) The total length of the thermometer shall be 200mm with a diameter of 12mm to 13mm.

3) At the top end a glass ring shall be provided with a diameter of approximately 2mm.

4) The scale divisions shall be 1˚C over a range of –20˚C to +70˚C. These graduations and figures shall be printed on the left-hand side of the scale.

5) The scale divisions on the right-hand side shall indicate the correction (the number of points that have to be subtracted or added) that must be made to the relative density reading, to obtain the correct reading for the reference temperature of 25 ˚C. For every 10 ˚C variation below 25 ˚C, subtract 7 points (0,007) from the hydrometer reading and for every 10 ˚C variation above 25 ˚C, add 7 points (0,007) to the hydrometer reading.

6) The calibration temperature shall be 25 ˚C.

7) The accuracy of the thermometer shall be at least 0.5 ˚C over the specified temperature range.

8) The thermometer shall be packed in a transparent plastic tube, with caps at each end. The packaging material shall prevent damage during normal handling and during transportation.

9) Refer to D-DT-9214 for a drawing of the thermometer.

3.5.1.10 An electronic hydrometer may also be offered.

3.5.1.11 The analogue hydrometer shall comply with the following requirements:

1) The aerometer shall be made of glass and the measuring range shall be from 1,100 kg/l to 1,300 kg/l.

2) The scale divisions on the aerometer shall be 0,005 kg/l and at least 2 mm apart.

3) The main divisions and figures on the aerometer shall be printed in black ink. The main divisions shall be visible 360˚ around the aerometer and the figures shall be printed on two opposite sides.

4) The sub divisions on the aerometer shall be printed in black ink and they shall be visible on two opposite sides of the aerometer.

5) A means shall be provided to ensure that the aerometer does not touch the walls of the body (that it floats with its axis vertical) during readings.

6) An inscription, in black ink, shall be printed at the bottom of the scale on the aerometer with the following wording: “ESKOM Tp. 25 ˚C”. The word, “Eskom” is optional.

7) The aerometer shall be calibrated at a reference temperature of 25 ˚C.

8) The total length of the aerometer shall be 165 mm.

9) The hydrometer body shall be made of glass.

10) The body length shall be 265 mm with diameters of 21,5 mm and 28,5 mm.

11) The suction bulb shall be made of black rubber with a diameter of 48 mm.

12) The socket shall be made of black rubber.

13) A transparent plastic tube with a length and diameter of 65 mm and 5 mm respectively, shall be provided to be inserted in the socket.

14) An extension hose made of red rubber, with a length and diameter of 100 mm and 7 mm respectively, shall be provided.

15) The accuracy of the hydrometer shall be within ± 0,005 kg/l, over the range of 1,100 kg/l to 1,300 kg/l.

16) The hydrometers shall be packed in a cardboard box, in such a way that will prevent accidental damage due to normal handling. The components shall be delivered unassembled in the box.

17) Refer to D-DT-9213 for a drawing of the hydrometer.

3.5.1.12 The battery logbooks shall comply with the following requirements:

1) The paper size shall be A4.

2) The front cover shall be made of 160g Tokai paper.

3) A light blue front cover shall be used for lead acid battery logbooks.

4) The instruction sheet shall be double sided and made of white bond paper.

5) The logsheets shall be printed on “No carbon required” (NCR) paper, which is perforated along the left-hand side.

6) A loose sheet of cardboard shall be provided with each logbook, which shall be used to write on thereby restricting the writing to the pair of logsheets being written on.

7) The original logsheet shall be white and the copy (NCR paper), which remains in the logbook, shall be yellow.

8) A total of 50 logsheets (originals plus copies) shall be provided per logbook.

9) The back cover of the battery logbook shall be made of grey chipboard.

10) Each logbook shall be issued with a clear plastic sleeve to protect it from the environment.

11) The logbooks shall be packaged in batches of 10.

12) Each logbook shall consist of a coversheet, instruction sheet and the set of logsheets.

13) The coversheet layout shall have the Eskom logo (centered at the top), “VENTED LEAD ACID BATTERY MAINTENANCE LOGBOOK” (centered, below the logo), followed by the following data (left-adjusted with dotted lines next to it for the applicable information to be filled out): “STATION”, “BATTERY FUNCTION”, “BATTERY MANUFACTURER”, “BATTERY/CELL MODEL” and “BATTERY NOMINAL VOLTAGE”. The following text shall appear in the bottom, left-hand corner: “KEEP BOOK IN A CLEAN AND DRY PLACE”.

14) The instruction sheet contents shall be in accordance with 240-118705836, Maintenance of Batteries.

3.5.1.13 Translucent 25l polycan clearly labelled for “First Aid Water” and

3.5.1.14 Translucent 25l polycan clearly labelled for “Battery Water”

3.5.2 Personal protective equipment

When specified in schedule A, the following personal protective equipment complying with the requirements of 240-44175132, Eskom Personal Protective Equipment (PPE), shall be made available:

1) Apron,

2) Face shield,

3) Gloves,

3.5.3 Maintenance equipment and PPE rack / cabinet / box

When called for by the Eskom, the tenderer shall supply a rack / cabinet / box for the storage of the maintenance equipment and PPE.

3.5.4 Battery stands

The battery stands shall comply with the following requirements:

3.5.4.1 It shall be supplied as a fully assembled or knocked-down kit, comprising all parts necessary to assemble the stand on site.

3.5.4.2 The material used shall be either (preference shall be indicated in Schedule A):

1) Meranti

2) Laminated pine

3) Synthetic plastic material containing a mixture of approximately 60% polyethylene, 25% polypropylene and 15% polystyrene. The lengths of the synthetic plastic have a square cross sectional area with a roughly circular core of polystyrene and a surrounding peripheral cladding of polyethylene and polypropylene. The peripheral cladding hardens to form an impervious, strong structure while the core remains light and porous. The aerated core confers strength on the structure. The length of the legs, transverse support beams and rack elements (runners), depend on the number of batteries or cells that must be supported by the stand.

3.5.4.3 The preferred material shall be indicated in schedule A.

3.5.4.4 All wood shall be well seasoned and free of knots.

3.5.4.5 Dimensions given for wooden beams are only a guide. All wooden beams shall be selected to be of acceptable thickness and strength to safely support the battery for 15 to 20 years, without showing visible signs of deflection or deterioration.

3.5.4.6 Plastic materials shall be free from creepage over the design life of 20 years, as demonstrated by the use of an accelerated aging test conducted at elevated temperatures.

3.5.4.7 All screws, nuts, bolts and washers shall be stainless steel grade AISI 316 of acceptable strength to safely carry the load for its particular application. All supplied coach screws shall be either stainless steel or galvanised mild steel.

3.5.4.8 A suitable hot-melt adhesive shall be used on all joints. All metal components shall be totally encapsulated in an acid resistant resin (e.g. Bitumen or Plastic).

3.5.4.9 Suitable cold glue for wood shall be used on all joints requiring glue.

3.5.4.10 The unassembled wood stand shall first be coated with a primer and then with one coat of the final coating material prior to delivery to site. After assembly at site, a second coat of the final coating material shall be applied to the entire stand. An adequate quantity of the final coating material shall be supplied with the stand.

3.5.4.11 A primer, which shall be suitable for application to wood while being compatible to the final coating material, shall be applied to the raw wood. The primer shall penetrate and effectively seal the wood.

3.5.4.12 Suitable primers are:

1) Pigmented alkyd based wood primer of which one coat shall be applied undiluted.

2) Pigmented nitro cellulose primer of which two or three coats shall be applied. This primer shall be diluted with 20% applied compatible thinners and proper drying shall be required between coats.

3.5.4.13 Black chlorinated rubber or an Eskom approved equivalent material shall be used as final coating material. The chlorinated rubber shall be applied undiluted.

3.5.4.14 No coating requirements applicable to plastic stands.

3.5.4.15 The runners shall be of acceptable strength to safely carry the selected cells over the unsupported length between stand legs.

3.5.4.16 The minimum dimensions of runner material shall be 70 mm x 55 mm or 65 mm x 65 mm.

3.5.4.17 The length of runners shall be equivalent to the total length of the stand.

3.5.4.18 The number of runners (beams) shall be sufficient to cover at least 75% of the top surface area of the stand.

3.5.4.19 The struts shall be of acceptable strength to safely support the weight of the runners and selected battery cells. The struts form the horizontal beams that run parallel to one another and perpendicular to the length of the stand.

3.5.4.20 The minimum dimensions of plastic struts shall be 25 mm x 75 mm and wood struts 20 mm x 70mm.

3.5.4.21 The length of transverse support members shall be equivalent to the total width of the stand.

3.5.4.22 A minimum quantity of 2 struts shall be installed.

3.5.4.23 The minimum dimensions of stand leg material shall be 70 mm x 55 mm or 65 mm x 65 mm. The narrow side shall face the front and back of the stand.

3.5.4.24 There shall be a minimum of two pairs of legs, one pair at each end of the stand with evenly spaced, additional pairs added in between, so that the runners are supported at least every 600 mm or 940 mm for wooden stands.

3.5.4.25 The minimum dimensions of material for braces shall be 25 mm x 75 mm for plastic and 20 mm x 70mm x 636,5mm for wood.

3.5.4.26 There shall be a minimum quantity of four braces, one at each corner of the stand and two for each alternate leg between the outside legs of the stand.

3.5.4.27 The battery stand layout shall comply with the following:

1) A 20 mm recess, cut into the inside of each of the two vertical beams of the stand leg shall hold the two horizontal beams at heights of 150 mm, from the floor, and 65 mm from the top end.

2) Two similar recesses shall be situated 250 mm from the floor height, on the outside of the vertical beams. These will accommodate the struts.

3) The runners shall be laid on the top horizontal beam of the stand leg.

4) The brace shall join the stand leg to the runner. The bottom corner shall be mounted 450 mm from the top of the stand and the same distance inwards on the runner, thereby forming a 45 degree angle to the leg and to the runner.

5) The battery stand shall comprise of at least four legs to which the transverse support members (struts) are attached. The transverse support member shall be attached to at least two legs. Sufficient numbers of braces and runners shall be used in assembling the stand to meet the requirements called for above. No legs or part of any leg will be in front or covering any installed cell.

3.5.4.28 The following shall be adhered to when joining wooden stands:

1) Runners shall be joined to the horizontal beams of the stand with one M10 galvanised coach screw at every point where they cross. The top side of the runner shall have an 11 mm (diameter) hole drilled through and counter-bored (top side only) with a 30 mm (diameter) hole that is 25 mm deep. The recessed head of the bolt, at the top, shall be sealed off by driving a wooden plug into the counter-bored hole after the final assembly.

2) Four spare wooden plugs shall be included as part of the assembly kit.

3) The struts shall be joined to each leg using two no. 12 x 45 mm long stainless steel wood screws. The holes shall be countersunk.

4) Each end of the brace shall be joined to the stand leg and the runner, using two no. 12 x 45 mm long stainless steel wood screws. The holes shall be countersunk.

5) The top and bottom horizontal sections of the stand leg shall be attached to the front and rear vertical sections using dowels and glue.

6) All pre-drilling and countersinking shall be done at the manufacturer's works to eliminate drilling during assembly at site.

3.5.4.29 The following shall be adhered to when joining synthetic plastic stands:

1) Each point of attachment between a transverse support beam and a leg is achieved using a lap joint. The lap joints are formed by a rebate (recess) in both members so that each member locates in the corresponding rebate on the other member, thereby interlocking. The members are initially retained in their interlocked position by applying a hot melt adhesive to their inner surfaces and by adhering them to one another before clamping. This method of jointing provides a flush bond between the transverse support beam and the leg. The smooth flush surface of the joint prevents the build-up of electrolyte spill on the stand by allowing any electrolyte spill to drain down the leg onto the floor of the battery room.

2) Each lap joint is firmly secured by passing a pair of hexagonal stainless steel bolts through the peripheral cladding at each of the joints. Each stainless steel bolt is recessed in a countersunk hole in each of the legs and recessed in a corresponding countersunk hole in each of the transverse support beams. The stainless steel bolts are secured in position by a stainless steel nut. The hot melt adhesive within the lap joint acts as a gasket around the stainless steel bolts protecting them from coming into contact with any acid and subsequent corrosion. It also fills the joint thereby eliminating any cracks or crevices within which any leaking acid may be trapped.

3) The recesses are sealed by inserting a plug in the form of a dowel of plastic / laminated Pine or hot melt adhesive into each countersunk hole. By binding the dowel to the plastic / laminated Pine material surrounding the hole, the flush surface of the leg is thereby retained.

4) The open framework design of the battery stand, allows for the adequate cooling of battery cells supported on them. The plastic / laminated Pine material provides a strong and corrosion resistant stand, especially as the jointing arrangement protects the stainless steel screws from coming into contact with any acid.

3.5.4.30 As a guideline the total height of a stand plus battery shall be 1200 mm but may not exceed 1500 mm ± 10mm.

3.5.4.31 The length and the width shall be such that the stand will safely support the specified battery without any danger of toppling over or the cells falling.

3.5.4.32 The clearance between the struts and the floor shall not be less than 150 mm, to enable easy cleaning.

3.5.4.33 A suitable rot stop shall be provided for the stand legs, when called for in schedule A of the enquiry documents. This could be in one of the following forms:

1) An insulator of suitable size and strength attached to the bottom of the leg, thus providing a distinct separation between the floor and the wood.

2) A moulded rubber cup that will completely seal the end of the stand leg.

3) Any other reliable means that will prevent moisture from coming into contact with the stand leg footing may be proposed. The method used shall be able to prevent the stand from moving during installation and carry the weight of the battery.

3.5.4.34 The following general stand arrangements are required:

1) Single row, single tier

2) Double row, single tier

3) Double row, stepped tier

4) Three row, stepped tier

5) Three row, centre terraced

6) Four row, centre terraced

3.5.4.35 With the installation of step stands it will be ensured that the top of the cells on the bottom row of the stand will be in line with the bottom of the cells installed on the top row of the stand to ensure that the mud trap of the top row of cells are visible for inspection at all times.

3.5.4.36 All cells will be installed face to face without any exceptions.

3.5.4.37 After assembly is complete the top surface area of the stand shall be level when the stand is mounted on a level floor.

3.5.4.38 All battery stand designs shall be submitted for load testing and certification provided by an accredited authority.

3.5.4.39 Only Eskom approved drawings (see Annex B) shall be used for production of the stands. Eskom reserves the right to inspect the stands both during and after installation, upon which the installation shall be certified by an authorised Eskom representative.

3.5.4.40 All wooden items shall be individually wrapped in cardboard sheets.

3.5.4.41 All items shall be suitably bound together to minimize damage during transport.

3.5.4.42 Detailed instructions of assembly and an inventory list of supplied items shall be included with each consignment.

3.5.5 Safety signs

When specified in schedule A, the manufacturer shall make safety signs available that comply with the requirements of *240-56362221, Standard for safety signs used in DC applications.*

3.6 Tests

3.6.1 General

3.6.1.1 All instruments employed for testing shall be of suitable quality and of sufficient accuracy for the particular test application. Eskom reserves the right to request instruments which have been certified by an authorised calibration authority.

3.6.1.2 Eskom shall be required to witness tests on the batteries.

3.6.1.3 Subject to Eskom's approval, evidence of equivalent tests performed on the offered equipment may be accepted provided that the results are available in the form of a fully detailed certified test report. It is the responsibility of the manufacturer to proof compliance with the required specifications in cases where the equipment complies with a similar specification.

3.6.2 Electrical and mechanical tests

3.6.2.1 The electrical and mechanical tests as stated in Table A.2 of SANS 60896-11, Stationary lead-acid batteries – Part 11: Vented types - General requirements and methods of test, shall apply.

3.6.2.2 Only type test certificates and test reports from accredited, independent test laboratories shall be accepted

3.6.2.3 Three copies of all type test reports and certification shall be supplied to Eskom not later than two weeks after completion of such tests.

3.6.3 Initial charge tests

3.6.3.1 Initial charge with capacity tests shall be performed by the manufacturer or representative at his works or at the indicated site, when wet charged cells are ordered.

3.6.3.2 Cells and batteries shall be initial charged in line with the requirements of 240-137465740, Standby battery storage and commissioning in Eskom.

3.6.3.3 All battery capacity discharge test conducted will be automated in terms of data captured which will all be date and time stamped as well.

3.6.3.4 Automated test results are to include the following data:

1) Cell voltages logged date and time stamped.

2) Battery bank voltage with discharge current logged for the duration of the discharge test.

3) These results shall be supplied in the original data logging reporting format.

4) To be supplied in hard copy but also be available in electronic format.

3.6.3.5 Full initial charge with capacity tests shall be performed by the manufacturer, representative or Eskom when required at the indicated site, when dry charged cells are ordered.

3.6.4 Clearance for dispatch

The supplier shall obtain agreement from Eskom's Quality Assurance Department before despatching the equipment. This agreement shall be confirmed on the routine test certificates.

3.7 Packaging, labelling and transport

3.7.1 Packaging

3.7.1.1 The products ordered shall be packaged in such a manner that the equipment is protected from damage in the event of a light drizzle as well as protected from bumps and scratches that could occur from normal handling and transport. The packaging shall be suitable for protecting the equipment from transport damage over long distances by road. The requirements of 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte, shall be complied with.

3.7.2 Labelling

3.7.2.1 The packages shall be clearly labelled with the station name, Eskom / contractor order number and the contents of the package. The requirements of 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte, shall be complied with.

3.7.2.2 Where an order contains clearly marked sub-orders (on the order documentation), the packaging of this order shall enable the separate sub-orders to be easily identified and easily separated (without opening crates or the movement of packages from one crate/consignment to another).

3.7.2.3 The maximum storage period and the commencement date of this period, of each consignment shall be clearly indicated on each package. Recommended storage conditions shall also be indicated.

3.7.3 Transport

3.7.3.1 Batteries are classified as hazardous goods and therefore the supplier or his agent shall ensure that road transportation of the batteries shall comply with the requirements of the National Road Traffic Act 93/1996. The requirements of 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte, shall be complied with.

3.7.3.2 Where transportation of the batteries is handled by the supplier’s agent or a third party, the supplier shall ensure that the proper documentation and packing and stacking instructions accompany each consignment and are adhered to.

3.7.3.3 Delivery shall include the transportation of the equipment to site or store and shall include both the offloading and placement of the goods into a designated area. The contractor shall be responsible for ensuring that the proper mechanisms are available for both offloading and placement of the equipment.

3.7.3.4 Where delivery to a designated store, workshop or substation is specified, the off-loading shall be the supplier’s responsibility and storage shall be Eskom's responsibility.

3.7.3.5 If delivery to a site is specified, the off-loading and storage either in an equipment room building or in a weatherproof location, provided by Eskom, shall be the supplier’s responsibility and therefore the relevant parties shall be contacted beforehand to ensure that authorised Eskom personnel are available to take possession of the delivery.

3.7.3.6 Eskom shall provide a location for offloading where the supplier will be able to use a pallet jack to move the batteries. Where a pallet jack cannot be used, rigging will be required and Eskom shall request for rigging services as a separate item.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Prince Moyo	Power Delivery Engineering GM
Richard McCurrach	Senior Manager – PTM&C CoE
Prudence Madiba	Senior Manager Electrical and C&I Engineering
Kashveer Jagdaw	DC & Auxiliary Supplies SC Chairperson
Deon van Rooi	Metering, DC & Security Technologies Manager
Thomas Jacobs	Chief Engineer DC & Auxiliary supplies

5. Revisions

Date	Rev	Compiler	Remarks
Sept 2020	3	C van Zyl	Informative reference updated General requirements updated on automated test results and OEM distribution formal agreements/appointment Wall mounted - and stand mounted Terminating Devices added plus inter-row cables Warranty requirements changed to at least 2 years full warrantee with additional pro-rata warranty Reference to standards updated throughout document Type test certificates for all size of cell plates and types added Logsheets to be supplied as per 240-118705836, Maintenance of Batteries standard Added requirement that all battery capacity discharge test conducted will be automated in terms of data captured

Date	Rev	Compiler	Remarks
March 2015	2	T Jacobs	Document reformatted into new template. References to SANS 1632-2-2005 removed as the document has been withdrawn. Updated the required capacities. Added the need for direct communication channels with the OEM and the OEM letter of accreditation requirements. Added that Kt factors shall be supplied. Removed "The manufacturer will be expected to provide a warranty of at least 12 years on flat and tubular plate designs and 20 years on Plantè plate design cells, and shall state clearly and unequivocally the conditions under which this warranty shall apply." Requirement to supply PPE was removed as an Eskom National Contract will be established for this purpose. Added the requirements of DSP_34-1066, Specification for Hydrometers and Thermometers used for Battery Maintenance, as a section. Added the requirements of the lead acid logbooks detailed in DSP_34-365, Distribution Specification – Part 16: Specification for lead acid and nickel cadmium battery logbooks, as a section. Added the requirements of 240-53114256, Specification for Lead Acid Battery Stands, as a section.
March 2013	1	M van Staden	New document created from GGSS 0829 & 36-813 as part of the TDAC process.

6. Development team

The following people were involved in the development of this document:

- Thomas Jacobs
- C van Zyl

7. Acknowledgements

Not applicable.

Annex A – Technical Schedules A and B

Stationary vented lead acid batteries

If different plate types are specified a complete set of technical schedules shall be prepared for each plate type.

Schedule A: Purchaser's specific requirements.

Schedule B: Guarantees and technical particulars of equipment offered.

Item	Description	Schedule A	Schedule B
3.1	**General Requirements**		
	Required cell types Flat plate (Fauré X) (2 V nominal) Planté plate (2 V nominal) Tubular plate (2 V nominal) Orders Wet charged cells Dry charged cells All accessories supplied Supply of all additional equipment and services Direct OEM communication OEM letter of certification / accreditation	 Yes Yes Yes Yes Yes - as specified Yes - as specified Yes - as specified Yes - as specified Yes - as specified Yes - as specified	
3.2	**Electrical Performance Requirements**		
3.2.2	Rated Capacity	As specified	
	Reference temperature [°C] Discharge period [h] End-of-discharge voltage per cell [V] Required capacity ranges [Ah]	25 10 1.80 Yes - as specified	
3.2.3	Discharge curves and tables	As specified	
	Discharge tables Kt factors	Specify Yes - as specified	
3.2.4	Suitability for floating operation	Comply	

Item	Description	Schedule A	Schedule B
	Fully charged state float parameters at reference temperature: Upper SG limit [kg/l] Lower SG Limit [kg/l] Voltage per cell [V] Boost charge voltage range per cell [V] Recommended boost charge frequency Conditions requiring boost charge Equalize charge voltage range per cell [V] Recommended equalize charge frequency Conditions requiring equalize charge Actual capacity = Rated capacity of 6 months float operation in accordance with SANS 60896-11	 Specify Specify Specify Specify Specify Specify Specify Specify Specify Yes - as specified	
3.2.5	Endurance		
	Comply with clause 9 of SANS 60896-11 **Expected life under specified conditions:** Flat plate (Fauré X) (2 V nominal) [yrs] Planté plate (2 V nominal) [yrs] Tubular plate (2 V nominal) [yrs] Expected end-of-life capacity for flat plate and tubular plate [Ah] Expected end-of-life capacity for planté plate [Ah] Expected rate of capacity deterioration under specified conditions [Ah/yr] Number of cycles to Ca = 0,8C10 for flat plate Number of cycles to Ca = 0,8C10 for tubular plate Number of cycles to end-of-life for planté plate Endurance in overcharge tested according to clause 17 of SANS 60896-11	Yes 15 20 12 0.8C10 C10 Specify Specify Specify Yes	
3.2.6	Charge retention		
	Obtained charge retention, CR, as a percentage of the initial capacity, Ca, according to clause 10 of SANS 60896-11	Specify	
3.2.7	Short-circuit current and internal resistance		
	Applicable standards Value of the short-circuit current, I_{sc} [A] Value of the internal resistance, R_i, at the reference temperature of 25°C at recommended SG and fully charged float voltage [mΩ]	SANS 1632-2: 2005 & SANS 60896-11 Specify Specify	
3.2.8	Tolerance to AC components of the DC supply		

Item	Description	Schedule A	Schedule B
	Maximum allowable ripple current and the effect thereof on expected battery life Effect on expected battery life where ripple is > 5%C10 during float charge and > 20%C10 during boost charge or equalise charge Effect on expected battery life where ripple is as specified.	Specify Specify Specify	
3.2.9	Effect of temperature		
	Effect of temperature on expected battery life Temperature derating factors for the temperature range of -5 °C to +45 °C	Specify Specify	
3.3	**Mechanical Requirements**		
3.3.1	General		
	Cell composition Resistance to mechanical stresses during normal transportation and handling Resistance to earthquakes required	As specified As specified No	
3.3.2	Plates		
	Plates construction Type of alloy Plates design characteristics	As specified Specify As specified	
3.3.3	Separators	As specified	
3.3.4	Group bars	As specified	
3.3.5	Terminal posts		
	Terminal posts design Recommended torque levels for the connections [Nm] Terminal posts loading	As specified Specify As specified	
3.3.6	Terminal seals	As specified	
3.3.7	Containers	As specified	
3.3.8	Cell lids	As specified	
3.3.9	Vent plugs	As specified	
3.3.10	Gas recombination units		

Item	Description	Schedule A	Schedule B
	Gas recombination unit available Catalyst life expectancy Catalyst Material Safety Datasheet Replaceable catalyst & no contamination of cell List of approved gas recombination units	Specify As specified Yes Yes Specify	
3.3.11	Hydrogen release		
	Float charge [cm3/h/Ah] Boost charge [cm3/h/Ah] Equalise charge [cm3/h/Ah] Elevated voltage without recombination unit [cm3/h/Ah] Elevated voltage with recombination unit [cm3/h/Ah]	Specify Specify Specify Specify Specify	
3.3.12	Electrolyte reserve		
	Water consumption over 6 month period Actual water consumption rate over 6 month period Topping-up period with recombination unit	As specified Specify Specify	
3.3.13	Containment of shedded active material	As specified	
3.3.14	Positive plate growth	As specified	
3.3.15	Cell orientation	As specified	
3.3.16	Cell markings and labelling		
	Positive terminal marked - indented or relief Minimum and maximum levels indicated Cell information Relevant safety information Cell numbers	Specify Yes As specified Yes Yes - As specified	
3.4	**Operational Requirements**		
3.4.1	Environmental conditions		

Item	Description	Schedule A	Schedule B
	Altitude [m] Relative humidity (non-condensing) [%] Lightning incidence Pollution Outdoor air temperatures: Maximum [°C] Average [°C] Minimum [°C] Battery room air temperatures: Maximum [°C] Daily average [°C] Minimum [°C]	2200 10 – 85 non-condensing High low - high with conductive particles when wet 45 35 -10 40 30 -5	
3.4.2	Application	For Information	
3.4.3	Charging regimes		
	Specified charging regimes accepted	Specify	
3.4.4	Commissioning		
	Specified commissioning practices accepted	Specify	
3.4.5	Maintenance		
	Specified maintenance practices accepted	Specify	
3.4.6	Battery water		
	Maximum conductivity [µS/cm] List of forbidden substances	Specify As specified	
3.4.7	Accessories		
	Bolts, nuts, washers and connectors	Yes - As specified	
3.4.8	Electrolyte	Yes - As specified	
3.4.9	Terminating devices and inter-row connectors	Yes - As specified	
3.4.10	Equipment Performance		
	Full track record Equipment hours of installed units / model / type Number of units in the field / model / type Environmental conditions where equipment installed	Specify Yes Yes Yes	

Item	Description	Schedule A	Schedule B
3.4.11	Type test certificates, drawings and instruction manuals		
	Cell parameters Technical manuals with specified cell information Installation manual Commissioning manual Maintenance manual Safety instructions Initial charge test results traceable to unique cells Material Safety Data Sheets available per consignment	Yes - As specified Yes - As specified Yes - As specified Yes - As specified Yes - As specified Yes - As specified Yes - As specified Yes - As specified	
3.4.12	Tools		
	Special tools or keys required	Specify	
3.4.13	Spares		
	Spares list, spares holding, etc.	Yes - As specified	
3.4.14	Training		
	Recommended course structure included Who will present the training Is there a possibility for training at principal's facilities Train-the-trainer type course	Yes Specify Specify Yes	
3.4.15	Warranty requirements		
	Two year guarantee Alternative warrantees OEM endorsed warrantees	Yes Specify Yes	
3.4.16	Local support	Yes - As specified	
3.4.17	Disposal	As specified	
	Certificates of environmentally friendly disposal / recycling Disposal in line with Eskom standard Collection of electrolyte and redundant cells from site Offset of scrap value against transportation costs	Yes Yes - As specified As specified As specified	
3.4.18	Equipment limitations	Specify	
3.5	**Ancillary Equipment**		
3.5.1	Maintenance equipment	See	
3.5.2	Personal protective equipment	No	

Item	Description	Schedule A	Schedule B
3.5.3	Maintenance equipment and PPE rack / cabinet / box	Yes - As specified	
3.5.4	Battery stands	Yes - As specified	
3.5.5	Safety signs		
3.6	**Tests**		
3.6.1	General	As specified	
3.6.2	Type tests	Specify	
	Capacity Test @ 25°C Suitability for floating battery operation test Endurance discharge cycle test Endurance test in overcharge Charge retention test Internal resistance test Short-circuit current test Test Certificates Clearance for Despatch	SANS 60896-11 Clause 14 SANS 60896-11 Clause 15 SANS 60896-11 Clause 16 SANS 60896-11 Clause 17 SANS 60896-11 Clause 18 SANS 60896-11 Clause 19 SANS 60896-11 Clause 19 Yes - As specified Yes - As specified	
3.6.3	Initial charge tests	As specified	
3.7	**Packaging, labelling and transport**		
3.7.1	Packaging	As specified	
3.7.2	Labelling	As specified	
3.7.3	Transport	As specified	

Annex B – Cell parameters

NOTE 1: Separate tables shall be completed for each plate type.

Required Capacity [Ah]	Plate Type 1)									
	Offered Capacity [Ah]	Cell Model No.	Short Circuit Current [A]	Internal Resistance [mΩ]	Recommended Torque Levels for Connections [N.m]	Electrolyte Volume to Max Level [l]	Electrolyte Volume to Min Level [l]	Cell Dimensions LxWxH [mm]	Dry Cell Weight [kg]	Wet Cell Weight [kg]
50										
100										
150										
200										
250										
300										
350										
400										
450										
500										
550										
600										
650										
700										
800										
900										
1000										

Required Capacity [Ah]	Plate Type 1)									
	Offered Capacity [Ah]	Cell Model No.	Short Circuit Current [A]	Internal Resistance [mΩ]	Recommended Torque Levels for Connections [N.m]	Electrolyte Volume to Max Level [l]	Electrolyte Volume to Min Level [l]	Cell Dimensions LxWxH [mm]	Dry Cell Weight [kg]	Wet Cell Weight [kg]
1100										
1200										
1300										
1400										
1500										
1600										
1700										
1800										
1900										
2000										
2100										
2200										

Annex C – Temperature derating factors

NOTE:

1) Separate tables shall be completed for each plate type.

2) The applicable time range shall be indicated e.g. “1s – 10min”

Temperature [°C]	**Plate Type** [1)]		
	Slow rate	**Medium rate**	**High rate**
	Time range [2)]		
-5			
0			
5			
10			
15			
20			
25			
30			
35			
40			
45			

Annex D – Maintenance equipment

	Item
1	Jug
2	Funnel
3	Anti-corrosion lubricant (at least 250ml)
4	Hydrometer
5	Thermometer
6	Maintenance & safety equipment board / rack
7	Lead acid battery logbook
10	Battery stand touch-up paint (500ml)
11	Battery stand touch-up paint (1000ml)
12	Paint brush - 50mm wide
13	Battery room safety sign, DCSS1 [3)]
14	Polycan (25l) - labelled for “First Aid Water”
15	Polycan (25l) - labelled for “Battery Water”

Annex E – Type tests schedule

NOTE 1: Separate tables shall be completed for each plate type.

Item	Test	Standard	Clause	Required Performance Criteria	Obtained Performance			Test Certificates Provided [Y/N]		
					Flat Plate	Tubular Plate	Planté Plate	Flat Plate	Tubular Plate	Planté Plate
1	Capacity Test @ 25°C	SANS 60896-11	14	PASS: Clause 14.10						
2	Suitability for floating battery operation test	SANS 60896-11	15	PASS: Clause 8.2 a) - d)						
3	Endurance discharge cycle test	SANS 60896-11	16	PASS: Clause 9.1						
4	Endurance test in overcharge	SANS 60896-11	17	PASS: Clause 9.2						
5	Charge retention test	SANS 60896-11	18	Specify obtained results						
6	Internal resistance test	SANS 60896-11	19	Tested						
7	Short-circuit current test	SANS 60896-11	19	Tested						

Annex F – Deviation schedule

NOTE 1: Separate tables shall be completed for each plate type.

Item	Clause	Proposed Deviation