Eskom	Standard	Technology

Title: **STANDARD SPECIFICATION FOR VALVE-REGULATED LEAD-ACID CELLS**

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Compiled by	Approved by	Authorized by
Thomas Jacobs	Christo van Zyl	Christo van Niekerk
Chief Engineer	Senior Technologist	SGM Technology (Acting)
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Supported by SCOT/SC

Richard McCurrach

PTM&C TC Chairperson

Date: 23/3/2018

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1. Introduction

This standard shall be used whenever valve-regulated lead acid batteries and its ancillary equipment need to be acquired by the business.

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 valve-regulated lead acid cells and its ancillary equipment.

2.1.1 Purpose

To specify the minimum technical requirements for valve-regulated lead acid batteries and its ancillary equipment.

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 60896-21, Stationary Lead Acid Batteries – Part 21: Valve regulated types – Methods of test

[4] SANS 60896-22, Stationary Lead Acid Batteries – Part 22: Valve regulated types – Requirements

[5] 240-53114264 Specification for safety signs used in DC application

[6] 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte

[7] 240-56177396 Battery capacity test

[8] 240-56227883 Battery Test for Acceptance and Type Testing of Lead Acid Vented Stationary Cells and Valve Regulated Sealed Lead Acid Cells Work Instruction

[9] 240-56356452 Maintenance of DC Supply Equipment Work Instruction

[10] 240-56535959 Management of Emergency AC and DC Supplies at Power Stations Standard

[11] 240-60725641, Specification for standard (10 inch) equipment cabinets.

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

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

2.2.2 Informative

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

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

[16] 240-118705836, Maintenance of Batteries.

[17] 240-44175132 Eskom Personal Protective Equipment (PPE)

[18] 240-56227923 Battery Quality Requirements

[19] 240-56356510 Definitions of Terms Applicable to DC Emergency Supplies standard

[20] 240-56177186 Acceptance and Commissioning of DC supply equipment

[21] 240-56176168 DC systems setting standard

[22] 240-53114248 Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies

[23] 240-56177396 Battery Capacity Test Manual

[24] 240-56177186 Design Guide for Power Station Battery Rooms Guideline

[25] 240-56176215 DC Technician Tools, Test Equipment and Accessories Standard

[26] 240-53114234 Specification for Battery Cabinets

[27] 240-56176852 Capacity of Essential Power Supplies for Power Stations Standard

[28] 240-56361888 Capacity of Essential Power Supplies for Telecommunication, Protection and Telecontrol Equipment Standard

[29] 240-53114314 Specification for the minimum reliability and capacity requirements of essential DC power supplies for various equipment at distribution sites

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].
Runners	The top horizontal beams that run parallel to one another along the length of the stand.

Definition	Description
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
AGM	Absorbed Glass Mat
DC	Direct Current
OEM	Original Equipment Manufacturer
RMS	Root Mean Square
SANS	South African National Standards
SG	Specific Gravity
VRLA	Valve-regulated Lead Acid

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

Not applicable

3. Requirements

3.1 General

a) The purchaser shall state which of the following cells shall be part of the scope:

   1) Flat plate (Fauré X)

   2) Planté

   3) Tubular

b) The cells shall be supplied in the fully charged state ready for installation.

c) The cells/batteries shall be capacity tested by the manufacturer/supplier at its works, before being transported to the required destination.

d) The applicable capacity test documentation shall be supplied with each consignment.

e) All cells/batteries shall be supplied complete with all necessary intercell connectors, nuts, bolts, washers, anti-corrosion lubricant and cell numbers.

f) The supplier shall, when requested, be responsible for the provision of maintenance equipment, safety equipment, safety and warning signs, battery stands, battery racks, battery cabinets, terminating devices, inter-row connectors and transportation; as well for the disposal of redundant cells. The requirements for these items are described later in this standard specification.

g) Direct communication access between Eskom and the OEM shall be catered for on technical issues.

h) The OEM letter of certification / accreditation of the local agent / supplier shall contain:

1) Distribution agreement,

2) Technical support offered,

3) Warranties offered

3.2 Electrical performance requirements

3.2.1 General

a) 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.

b) All requirements shall be specified at a reference temperature of 20 °C, unless otherwise specified.

3.2.2 Rated Capacity

a) The rated capacity, Crt, 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, Uf.

b) The rated capacities shall be specified at a reference temperature of 20 °C, over a discharge period of 10 h to a final end-of-discharge voltage of 1,80 V/cell.

c) Table 1 shows the required capacity ranges, unless otherwise specified:

Table 1: Required ampere-hour capacities

C10 at 20 °C to end-of-discharge voltage of 1.80 V/cell		
<50	500	1 300
50	550	1 400
100	600	1 500
150	650	1 600
200	700	1 700
250	800	1 800
300	900	1 900
350	1 000	2 000
400	1 100	2 100
450	1 200	2 200

d) 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

a) The tenderer shall submit discharge tables that indicate the discharge performance for offered cells at a reference temperature of 20°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.

b) The tenderer shall submit the K**t** factors (capacity rating factors) for the offered cells with C**rt** as specified in b). The K**t** factors shall be tabulated for the same end-of-discharge voltages and discharge periods as specified in a).

3.2.4 Charging voltages

a) The offered cells shall be suitable for float charge operation.

b) The tenderer shall state the recommended float voltage setting range at the reference temperature.

c) The tenderer shall state the recommended boost charge voltage range (at the reference temperature) as well as the recommended frequency of boost charging, or the conditions in which boost charging is recommended.

d) The tenderer shall state the recommended equalize charge voltage range (at the reference temperature) as well as the recommended frequency of equalize charging, or the conditions in which equalize charging is recommended.

3.2.5 Tolerance to AC components of DC supply

a) The tenderer shall state the maximum allowable ripple current and the effect thereof on expected battery life, at the reference temperature of 20 °C.

b) If the actual ripple current is more than 0,05C10 during float charge and 0,2C10 during boost charge or equalize charge, the value of the ripple current shall be specified by the purchaser, and the tenderer shall state the effect on expected cell/battery life.

3.2.6 Effect of temperature

a) The tenderer shall state the effects of temperature on the expected cell/battery life in table format or on a graph.

b) The tenderer shall state, in table format or on a graph, the effects of temperature on the available capacity for the temperature range of -5 °C to +45 °C. Temperature derating factors shall be indicated.

c) The tenderer shall state the recommended temperature compensation factor/s to prevent over- and undercharging of cells.

3.3 Safe operation requirements

3.3.1 Test conditions and method of test

a) All test conditions and methods of test shall be as specified in [3], SANS 60896-21, Stationary Lead Acid Batteries – Part 21: Valve regulated types – Methods of test.

3.3.2 Gas emission

a) The tenderer shall report the gas emission volumes (reported as hydrogen) under normal float and overcharge voltage conditions of 2,4 V/cell.

b) The gas volume in millilitres (ml), time duration in hours (h) and capacity in ampere-hours (Ah) of the battery under test shall be reported at the reference temperature of 20 °C.

3.3.3 High current tolerance

a) The high current tolerance test is required to verify that the design of the internal current-conducting components is robust enough to safely handle short periods of abnormally high discharge current.

b) The unit under test shall show no evidence of incipient melting or loss of electrical continuity after 30 s of high current flow.

c) The value of the measured current shall be stated.

3.3.4 Short-circuit current and DC internal resistance

a) The tenderer shall specify the prospective short-circuit value (Isc) in amperes (A) of all offered cells/batteries.

b) The tenderer shall specify the internal resistance (Ri) in ohm (Ω) of all offered cells/batteries.

3.3.5 Internal ignition protection

a) The purpose of this requirement is to evaluate the adequacy of protective features such as the valve/flame barrier assembly as a safeguard against the ignition of gases, within the volume enclosed by the valve, from an external ignition source.

b) No evidence of rapid combustion or explosion beyond the valve/barrier assemblies shall occur.

3.3.6 Ground short propensity protection

a) The purpose of this requirement is to confirm the satisfactory resistance of the units toward phenomena enhancing ground shorts, such as the occurrence of an electrolyte breakthrough at seals, joints or terminals.

b) No evidence of ground short and leakage phenomena shall be present.

3.3.7 Marking content and durability

a) The purpose of this requirement is to ensure the presence of essential product and safety information on each unit and their legibility after exposure to a prescribed set of chemicals.

b) After exposure to the set chemicals, the information shall remain readable and remain in place.

c) The tenderer shall specify the approved cleaning agent to be used for cell cleaning.

d) The following minimum technical information shall be displayed:

1) Polarity sign at the positive terminal(s) with a + symbol radius of at least 6 mm.

2) Manufacturer and/or vendor name.

3) Country of origin of unit.

4) Type designation of unit.

5) At least one rated capacity (C10, C8, C3, C and C0.25) and its final voltage in V/cell or V/unit.

6) Rated temperature (20 °C or 25 °C) for the capacity value.

7) Float voltage in V/cell or V/unit at a rated temperature of 20 °C and/or 25 °C.

8) Date of manufacture in clear unequivocal mm.yyyy format.

e) The following minimum International Organization for Standardization (ISO) warning symbols (where space allows) shall be present, with 11 mm diameter minimum size and in two contrasting colours:

1) Warning

2) Electrical danger

3) No open fires and sparks

4) Wear eye protection

5) Read instructions

f) The following environmental protection and recycling symbols shall be present:

1) Recycling symbol

2) Crossed-out waste bin

g) To enhance the recycling of material for environmental protection, the plastic materials used for the units shall be clearly identified with the ISO 1043-1 material symbol and legible throughout the service life.

h) The applicable ISO symbol shall be present on the outside of the cover or/and case and the symbol shall remain readable after exposure to set chemicals and remain in place.

3.3.8 Valve operation

a) The purpose of this requirement is to ensure that the valve of the cell will function properly as a one-way vent over the service life of the unit.

b) Gas release shall be detected before and after the specified stress temperature impact test.

3.3.9 Material flammability rating

a) The purpose of this requirement is to determine and classify the flammability rating of the case and cover material.

b) The tenderer shall state the flammability rating level for samples of thickness equivalent to that of case and cover.

3.3.10 Intercell connector performance

a) The purpose of this requirement is to determine if a high temperature (T > 70 °C) hazard exists on the connector during a high rate discharge.

b) The tenderer shall report the maximum intercell connector temperature reached.

3.4 Performance requirements

3.4.1 Test conditions and methods of test

All test conditions and methods of test shall be as specified in [3], SANS 60896-21, Stationary Lead Acid Batteries – Part 21: Valve regulated types – Methods of test.

3.4.2 Discharge capacity performance

a) The purpose of this requirement is to confirm the capacity to a specific end-voltage at the selected discharge rate or rates, at the moment of unit dispatch.

b) The sample cells shall have at least delivered an actual capacity (Ca) of ≥ 0,95 Crt.

3.4.3 Charge retention during storage

a) The purpose of this requirement is to show the actual capacity retained after a set period of time in storage of a fully charged unit.

b) Each individual test unit shall have a retained capacity of at least ≥ 0,7 Crt after six months of storage.

3.4.4 Float service with daily discharges

a) The purpose of this requirement is to define the aggregate capacity and cycling behaviour of the battery undergoing very frequent or even daily discharges, such as experienced in areas with irregular or insufficient main supply, and where recharge can be carried out only under float voltage settings conditions.

b) The tenderer shall report the capacity available and total number of cycles achieved under float voltage settings (Caf) and boost voltage settings (Cab) for reliable mains power, unreliable mains power and very unreliable mains power.

3.4.5 Recharge behaviour

a) The purpose of this requirement is to define the capacity available following a long duration discharge with both short (24 h) and long (168 h) periods of recharge under float voltage settings.

b) The effective available capacity, as a percentage of the original capacity after a recharge for 24 h and 168 h using only the recommended float voltage setting shall be at least 90% and 98%, respectively.

3.4.6 Critical depth of discharge

a) The purpose of this requirement is to ensure that the cells are not discharged beyond a critical level which may adversely affect their expected life.

b) The tenderer shall state the maximum depth of discharge in both ampere-hours and V/cell at which the load disconnection device shall be activated.

3.5 Durability requirements

3.5.1 Test conditions and methods of test

All test conditions and method of test shall be as specified in [3], SANS 60896-21, Stationary Lead Acid Batteries – Part 21: Valve regulated types – Methods of test.

3.5.2 Service life at reference temperature

a) The purpose of this requirement is to elicit standardized information about the service behaviour of the units under reference operating temperatures and recommended float voltage settings.

b) The tenderer shall state the days at the reference temperature, on float charge, of the units to a residual capacity of 0,8 Crt after a 3 h rate discharge test.

3.5.3 Service life at elevated operating temperature

a) The purpose of this requirement is to elicit standardized information about the service behaviour of the units under elevated but realistic operating temperatures and float voltage settings.

b) The tenderer shall state the days at 40 °C, on float charge, of the units to a residual capacity of 0,8 Crt after a 3 h rate discharge test.

3.5.4 Impact of stress temperature

a) The purpose of this requirement is to elicit information on how long units perform under elevated temperature stress conditions of 55 °C and 60 °C.

b) The tenderer shall report the days at elevated temperature, on float charge, of the units to a residual capacity of 0,8 Crt after both 3 h rate and 0,25 h rate discharge tests.

3.5.5 Impact of abusive over-discharge

a) The purpose of this requirement is to ensure that units undergoing abusive over-discharges during their service life, show a minimum of capacity recovery under specified conditions.

b) The unbalanced string over-discharge capacity (Caod) shall be ≥ 0,80 Crt for the string.

c) The cyclic over-discharge capacity (Caoc) shall be ≥ 0,90 Crt for the string.

3.5.6 Thermal runaway sensitivity

a) The purpose of this requirement is to elicit standardized information about how soon units may enter thermal runaway conditions when exposed to higher than normal voltages under specified conditions.

b) The units shall achieve at least one week below 60 °C at 2,45 V/cell and at least 24 h below 60 °C at 2,60 V/cell.

c) The tenderer shall state the ultimate time to 60 °C or ultimate temperature after 168 h at 2,45 V/cell and 2,60 V/cell.

3.5.7 Capacity impact of low temperature service

a) The purpose of this requirement is to ensure that units experiencing abusive low temperature conditions during service life show a minimum of mechanical stability against freezing induced forces, and adequate capacity recovery under specified conditions.

b) The available capacity shall be > 0,95 Crt with no bulging, fractures and other induced mechanical damages.

3.5.8 Dimensional stability at elevated internal pressures and temperatures

a) The purpose of this requirement is to determine the potential deformations of the units to be expected and related clearances needed.

b) The tenderer shall state dimensional changes in percentage and in millimetres.

3.5.9 Stability against mechanical abuse

a) The purpose of this requirement is to detect the propensity of a cell/monobloc to fracture and leak when dropped, unpacked during transport or installation.

b) No leakage shall be detectable after two times two drops.

3.6 Other requirements

3.6.1 Cell numbers

a) 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.

b) 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.

c) 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.

d) 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.

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

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

3.6.2 Recommended torque values

The tenderer shall state the recommended torque values for all connections in newton-metres (N·m).

3.6.3 Recommended cell orientation

The tenderer shall state the recommended cell orientation (upright or sideways) for each offered cell/battery, which will not affect its expected performance.

3.7 Operational requirements

3.7.1 Environmental conditions

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

3.7.1.1 Outdoor air temperatures

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

3.7.1.2 Battery room air temperatures

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

3.7.2 Application

The batteries are used in a stationary application for the supply of backup power during AC supply failure conditions at sites. The Valve-regulated Lead–acid (VRLA) batteries are normally used at telecommunications sites and in office environments. They might be used in substations where space constraints exist. The batteries are installed in cabinets or open racks.

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 Table 2. The required standby times are specified.

Table 2: 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.

3.7.3 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 flooded 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.

3.7.4 Commissioning

a) Cells and batteries shall be commissioned in line with the requirements of 240-56177186 Acceptance and Commissioning of DC supply equipment. This document relates to the initial charge of the cells.

b) 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 240-56177186 Acceptance and Commissioning of DC supply equipment.

3.7.5 Maintenance

a) Cells and batteries shall be maintained in line with the requirements of 240-56356452 Maintenance of DC Supply Equipment Work Instruction and 240-56535959 Management of Emergency AC and DC Supplies at Power Stations Standard.

b) 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 240-56356452 Maintenance of DC Supply Equipment Work Instruction and 240-56535959 Management of Emergency AC and DC Supplies at Power Stations Standard.

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

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

3.7.6 Accessories

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

b) 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.

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

3.7.7 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.

3.7.8 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.

3.7.9 Test certificates, drawings and instruction manuals

When called for in schedule A, copies of test certificates shall be submitted with tender documentation.

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

1) Cell type,

2) C10 rated capacity [Ah],

3) Wet weight mass [kg],

4) Cell dimensions (length, width, height) [mm],

5) Number of terminals and

6) Terminal location (front or top).

3.7.9.2 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 and capacity test results, in the case of wet charged cells.

3) The material safety datasheets for the cells, electrolyte and any other hazardous material which form part of the consignment.

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

3.7.10 Tools

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

3.7.11 Spares

a) 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.

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

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

d) 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.

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

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

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

3.7.12 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.

3.7.13 Warranty requirements

1) The tenderer shall offer at least a one year guarantee from date of delivery.

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

3.7.14 Local support

a) 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.

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

3.7.15 Disposal

a) 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.

b) Any disposal of redundant cells and electrolyte shall be in line with Eskom disposal procedure, 240-56227788, Safe disposal of redundant batteries.

c) 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.

d) 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.

3.7.16 Equipment limitations

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

3.8 Ancillary equipment

3.8.1 Maintenance equipment

When specified in schedule A, the following maintenance equipment, as per 240-56356452, Maintenance of DC Supply Equipment Work Instruction shall be made available:

a) Anti-corrosion lubricant – at least 250 ml,

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

c) Paint brush – 50 mm wide.

d) Pack of paper towels.

e) An electronic thermometer – gun type with infra-red sensing

f) 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 cardboard.

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 as indicated in 240-118705836, Maintenance of Batteries.

3.8.2 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,

3.8.3 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.

3.8.4 Battery cabinets

a) The battery cabinets shall comply with the requirements of 240-60725641, Specification for standard (19 inch) equipment cabinets.

b) The user shall indicate if the cabinets shall be swingframe or fixed frame cabinets.

c) The user shall indicate if the cabinets shall be with or without doors.

d) The user shall indicate if the cabinets shall be with or without side panels in cases where more than one cabinet need to be placed side-by-side.

e) The trays / racks for the batteries shall be sufficiently strengthened to carry the weight / load safely.

3.8.5 Battery stands

The battery stands shall comply with the following requirements:

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

g) 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.

h) The preferred material shall be indicated in schedule A.

i) All wood shall be well seasoned and free of knots.

j) 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.

k) 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.

l) 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.

m) 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).

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

o) 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.

p) 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.

q) 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.

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

s) No coating requirements applicable to plastic stands.

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

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

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

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

x) 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.

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

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

aa) A minimum quantity of 2 struts shall be installed.

bb) 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.

cc) 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.

dd) 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.

ee) 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.

ff) 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.

gg) 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.

hh) 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.

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

jj) 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.

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

ll) 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.

mm) 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

nn) 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.

oo) All cells will be installed face to face without any exceptions.

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

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

rr) 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.

ss) All wooden items shall be individually wrapped in cardboard sheets.

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

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

3.8.6 Safety signs

When specified in schedule A, the manufacturer shall make safety signs available that comply with the requirements of *240-53114264*, *Specification for safety signs used in DC applications.*

3.9 Tests

3.9.1 General

a) 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.

b) Eskom shall be required to witness tests on the batteries.

c) 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.

3.9.2 Type tests

All test conditions and method of test shall be as specified in [3], SANS 60896-21, Stationary Lead Acid Batteries – Part 21: Valve regulated types – Methods of test, as indicated in Table 3, Table 4 and Table 5.

Table 3: Safe operation characteristics

Test Clause	Measures
6.1	Gas emission
6.2	High Current Tolerance
6.3	Short circuit current and DC internal resistance
6.4	Protection against internal ignition from external spark sources
6.5	Protection against ground short propensity
6.6	Content and durability of required markings
6.7	Material identification

Test Clause	Measures
6.8	Valve operations
6.9	Flammability rating of materials
6.10	Intercell connector performance

Table 4: Performance Characteristics

Test Clause	Measures
6.11	Discharge capacity
6.12	Charge retention during storage
6.13	Float service with daily discharges
6.14	Recharge behaviour

Table 5: Durability Characteristics

Test Clause	Measures
6.15	Service life at an operating temperature of 40 °C
6.16	Impact of a stress temperature of 55°C or 60 °C
6.17	Abusive over discharge
6.18	Thermal runaway sensitivity
6.19	Low temperature sensitivity
6.20	Dimensional stability at elevated internal pressure and temperature
6.21	Suitability against mechanical abuse of units during installation

3.9.3 Test certificates

Three copies of all type test certificates shall be supplied to Eskom as part of the tender documentation.

3.9.4 Clearance for dispatch

a) The supplier shall obtain agreement from Eskom's Quality Assurance Department before dispatching the equipment.

b) This agreement shall be confirmed on the routine test certificates.

3.9.5 Commissioning tests

When wet charged cells are ordered, commissioning tests shall be performed by the supplier at its works and the test results shall be supplied with each consignment.

3.10 Packaging, labelling and transport

3.10.1 Packaging

a) 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.

3.10.2 Labelling

a) 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 adhered to.

b) 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).

c) 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.

3.10.3 Transport

a) 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 adhered to.

b) 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.

c) 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.

d) 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.

e) 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.

f) 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
Richard McCurrach	Senior Manager – PTM&C CoE
Deon van Rooi	Metering, DC & Security Technologies Manager – PTM&C CoE (Acting)
Kashveer Jagdaw	DC & Auxiliary Supplies SC Chairperson
Christo van Zyl	Battery Care Group Convenor – DC & Auxiliary Supplies SC

5. Revisions

Date	Rev	Compiler	Remarks
April 2018	2	T Jacobs	Document reformatted into new template. Battery cabinet requirements added.

Date	Rev	Compiler	Remarks
March 2013	1	W Pringle	First issue

6. Development team

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

- Thomas Jacobs

7. Acknowledgements

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