Eskom	Standard	Technology

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	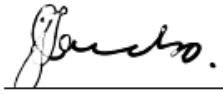	
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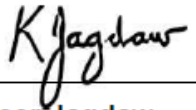

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1. Introduction

This standard contains information regarding the technical requirements of Stationary Vented Nickel Cadmium Batteries utilising recombination technology, accessories and ancillary equipment.

2. Supporting clauses

2.1 Scope

This specification details the technical requirements with respect to the design, manufacture at works, testing, quality assurance, delivery to site, off-loading, erection, commissioning and de-commissioning of vented (inclusive of semi-sealed) nickel cadmium cells, its accessories and ancillary equipment.

2.1.1 Purpose

The document addresses the standard documented technical specifications to be used when evaluating Stationary Vented Nickel Cadmium 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] IEC 1632-1: 2005, Batteries Part 1: General information – Definitions, abbreviations and symbols.

[3] SANS 10108:2014, The Classification of Hazardous Locations and the Selection of Apparatus for use in such locations

[4] SANS 10119:2011, Reduction of Explosion Hazards Presented by Electrical Equipment – Segregation. Ventilation and Pressurization

[5] SANS 62259: 2005, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination.

[6] 240-56227923, Battery Quality Requirements

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

2.2.2 Informative

[8] 240-137465740, Standby battery storage and commissioning in Eskom

[9] 240-61182045, Maintenance engineering standard for batteries and chargers

[10] 240-56176168, DC systems setting standard.

[11] 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte.

[12] 240-56227923, Quality Requirements for Stationary Vented Nickel Cadmium and Lead Acid Batteries for Power Stations Specification

[13] 240-56177186, Battery room standard

[14] 240-56176852, Essential Power Supplies for Power Stations Standard

[15] 240-118705836, Maintenance of Batteries

[16] 240-118870219, Standby power systems topology and autonomy for Eskom

[17] 240-56362221, Standard for safety signs used in DC applications

2.3 Definitions

2.3.1 General

Definition	Description
DC system	Consists of a battery charger which is connected in parallel to a standby battery bank for the provision of the DC power to the required load equipment.
Partial gas recombination	Ability of a cell to recombine most of the gases evolved during charging
Rated capacity	Quantity of electricity C_5Ah (ampere hours), declared by the manufacturer, which a fully charged single cell can deliver to a specified end-of-discharge terminal voltage during a 5h discharge period at a specified electrolyte temperature.

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_5	5 hour rated capacity
CFS	Combined fuse switch
DC	Direct current
Nicad	Nickel Cadmium
OEM	Original equipment manufacturer
PPE	Personal protective equipment
RMS	Root mean square
SANS	South African National Standards
SG	Specific gravity
SoH	State-of-health

2.5 Roles and responsibilities

The battery care group leader must ensure that this document is updated, renewed and current at all times.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Section 3.5.1.2 of this document replaces the contents related to Nickel Cadmium battery logbooks in 240-76627823, Lead Acid and Nickel Cadmium Battery Logbooks Standard.

3. Stationary vented nickel cadmium 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 nickel cadmium cells (1.2V nominal) to Eskom stores or sites.

b) The cells shall employ recombination technology complying with the requirements of SANS 62259: 2005 or IEC 62259: 2003, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination.

c) The cells shall be supplied in the wet, charged state with test results per cell as indicated in schedule A.

d) The cells shall be commissioned and capacity tested with automated test results by the manufacturer / supplier at his works, before being transported to the required destination.

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) All battery banks shall be supplied complete with all necessary inter-cell connectors, nuts, bolts, washers, anti-corrosion lubricant, cell numbers and capacity test reports.

g) When required the supplier shall also be responsible for the provision of maintenance equipment, safety equipment, battery cabinets, terminating devices and inter-row connectors, transport and disposal of used cells, of which the requirements shall be stated below.

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

i) Original Equipment Manufacturer 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 to a specified end-of-discharge (final) voltage, U_f. The requirements of SANS 1632-3: 2005, Batteries Part 3: Vented-type prismatic nickel-cadmium cells and batteries, shall apply.

3.2.2.2 Unless otherwise specified, the rated capacities shall be specified at a reference temperature of 20°C, over a discharge period of 5h to a final end-of-discharge voltage of 1,00V/cell.

3.2.2.3 The required battery capacities shall be specified in the enquiry document.

3.2.3 Discharge curves and tables

The manufacturer shall submit discharge curves and / or tables that indicate the discharge performance for offered cells at a reference temperature of 20°C, to the end-of-discharge voltages of 1,00V/cell, and 1,05V/cell, over the following discharge periods:

sec, 1 min, 10 min, 1 hr, 2 hr, 3 hr, 4 hr, 6 hr, 8 hr, 10 hr, 12 hr, 16 hr, 18 hr, 24 hr, 32 hr.

3.2.4 Suitability for floating operation

3.2.4.1 The requirements of SANS 62259: 2005, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination.

3.2.4.2 The manufacturer shall indicate the SG and the actual voltage per cell in the fully charged floating state, in schedule B.

3.2.4.3 The manufacturer shall indicate the recommended boost voltage per cell in schedule B.

3.2.4.4 The manufacturer shall indicate the recommended equalise voltage per cell in schedule B.

3.2.4.5 The manufacturer shall also indicate the recommended frequency of boost charges in schedule B.

3.2.4.6 The manufacturer shall also indicate the recommended frequency of equalise charges in schedule B.

3.2.5 Endurance

3.2.5.1 The requirements of SANS 1632-3: 2005, Batteries Part 3: Vented-type prismatic nickel-cadmium cells and batteries, shall apply.

3.2.5.2 The expected life of the cell or battery shall be 17 years under the conditions as specified in 3.4.1.

3.2.5.3 The expected end-of-life capacity shall be not less than 80%C5.

3.2.5.4 The manufacturer shall indicate in schedule B the expected rate of deterioration (capacity loss) over the cell or battery's life under the conditions as specified in 3.4.1.

3.2.5.5 The manufacturer shall indicate in schedule B the number of cycles to Ca = 80%C5.

3.2.6 Charge retention

The requirements of SANS 62259: 2005, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination, shall apply. The manufacturer shall indicate in schedule B the obtained charge retention, C_R, as a percentage of the initial capacity, C_a.

3.2.7 Short-circuit current and internal resistance

3.2.7.1 The manufacturer shall indicate in schedule B the value of the short-circuit current, I_{sc}.

3.2.7.2 The manufacturer shall indicate in schedule B the value of the internal resistance, R_i, at the reference temperature of 20°C.

3.2.8 Tolerance to AC components of the DC supply

3.2.8.1 The manufacturer shall indicate, in schedule B, the maximum allowable RMS ripple current and the effect on expected battery life.

3.2.8.2 The manufacturer shall indicate, in schedule B, the maximum allowable RMS ripple voltage and 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 tenderer 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 tenderer 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 +50°C. Temperature de-rating factors shall be indicated.

3.3 Mechanical requirements

3.3.1 General

3.3.1.1 Eskom shall specify in schedule A what types of nickel cadmium cells are required. The purchaser shall indicate whether it is Low, Medium, High or Extra High performance type cells.

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 in schedule A.

3.3.2 Battery Cabinet

Eskom shall indicate in the Technical Schedules if battery cabinets are required. The battery cabinet shall comply with the requirements of item 3.5.4.

3.3.3 Terminal posts

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

3.3.3.2 The terminal posts shall be compatible with the electrochemical conditions within the cell and shall be suitable for mechanical connections. The manufacturer shall indicate, in schedule B, recommended torque levels for the connections.

3.3.4 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.

3.3.5 Containers

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

3.3.5.2 The electrolyte levels inside the cells must be clearly visible.

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

3.3.5.4 The cell containers shall be a single moulded jar per cell and not block configurations. No welded seams will be accepted.

3.3.6 Cell lids

3.3.6.1 The cell lids shall be sealed to the container.

3.3.6.2 The complete cell shall be sufficiently sealed to handle the internal pressure during normal operation. The tenderer shall state, in schedule B, the maximum internal pressure that the offered cells can handle.

3.3.7 Vent plugs

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

3.3.7.2 The plugs shall be designed so that the escape of gases as per the recombination technology from the cells is permitted, but also that electrolyte spray is trapped and returned to the cells.

3.3.8 Electrolyte reserve

3.3.8.1 The electrolyte reserve shall be sufficient to ensure that the electrolyte level shall not fall below the topping up mark within a minimum period of 36 months under the conditions as specified in 3.4.1. If the actual period under stated conditions is in excess of 36 months, then the tenderer shall indicate that period in schedule B. The preferred option is a recombination cell with flooded electrolyte.

3.3.8.2 The tenderer shall state, in schedule B, the maximum period that can be attained at the environmental temperatures as indicated in 3.4.1.

3.3.8.3 The supplier shall state, in schedule B, the volume of the reserve per cell in litres and as a percentage of the total cell volume.

3.3.9 Cell marking and labelling

3.3.9.1 The requirements of SANS 62259: 2005, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination, shall apply.

3.3.9.2 The minimum / topping up and maximum levels shall be clearly indicated on the container wall.

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

3.3.9.4 Cell numbers shall comply with the following requirements:

3.3.9.5 Each cell shall have a label indicating the number of the cell. These numbers shall run consecutively, commencing with the most positive cell as number one.

3.3.9.6 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.

3.3.9.7 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.

3.3.9.8 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 is not impeded.

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

3.3.9.10 When specified in schedule A, 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 or storage under the following conditions:

1)	altitude	:	2 200 metres maximum
2)	relative humidity	:	10% to 85% non-condensing
3)	lightning	:	high lightning area

3.4.1.2 Outdoor air temperatures:

1)	maximum	:	40 °C
2)	daily average	:	30 °C
3)	yearly average	:	20 °C
4)	minimum	:	-10 °C

3.4.1.3 Equipment room air temperatures:

1)	maximum	:	50 °C
2)	daily average	:	35 °C
3)	yearly average	:	25 °C
4)	minimum	:	-5 °C

3.4.1.4 Storage temperatures:

1)	maximum	:	35 °C
2)	daily average	:	25 °C
3)	yearly average	:	20 °C
4)	minimum	:	-5 °C

3.4.2 Application

Nickel cadmium batteries are used at the substations, in a stationary application, for the supply of backup power during AC supply failure conditions at sites. The batteries are of the flooded (vented) type and are installed in battery cabinets inside the equipment rooms. The loads that are normally connected to the DC system include protection relays, spring rewind motors of HV switchgear, telecontrol equipment (RTU's), telecommunications equipment, control and instrumentation, distributed control systems and emergency lights.

The main voltages and amount of cells, per battery bank, used are indicated in Table 1. The substation standing drain is relatively low, with the required standby times dependant on the application and configuration used. The required standby times are as per 240-56176852, Capacity of Essential Power Supplies for Power Stations Standard or 240-118870219, Standby power systems topology and autonomy for Eskom sites whichever is applicable.

Table 1: Guideline for number of cells per nickel cadmium battery

Voltage [V]	Number of cells1)
12	10
24	20
36	30
50	38
110	85[2)]
220	170
NOTE 1: For systems with high or low voltage constraints, less or more cells may be used. NOTE 2: Typical 88 cells are used for solenoid operated equipment.	

In designs where the maximum required battery charging voltage are higher than the maximum input voltage limit of the operating 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. The charging mode in which the battery is most of its life is called the float charging mode, which is high enough to maintain a high level of available capacity, but also low enough to optimise the top-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. This charge mode is also applied after a prolonged AC failure condition at site to recharge the batteries as quickly as possible.

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

3.4.4 Hydrogen release

The hydrogen release at each of the charging regimes in 3.4.3 shall be supplied.

The hydrogen release for cells equipped with recombination technology shall be supplied at an elevated voltage of 1,70V/cell equivalent to an elevated charge voltage of 2,40V/cell applicable to valve regulated batteries as stipulated in *SANS 10108, The Classification of Hazardous Locations and the Selection of Apparatus for use in such locations.* The battery cabinet design shall comply with the requirements of *SANS 10119, Reduction of Explosion Hazards Presented by Electrical Equipment – Segregation. Ventilation and Pressurization.*

3.4.5 Commissioning

3.4.5.1 All Nicad cells to be given a fully documented commissioning charge just before or after installation at site.

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

3.4.5.3 The tenderer shall state, in schedule B, the acceptance of these conditions. If these conditions are not accepted, then the tenderer 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.

3.4.6 Maintenance

3.4.6.1 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.

3.4.6.2 The manufacturer shall state, in schedule B, the acceptance of these conditions. If these conditions are not accepted, then the tenderer shall include maintenance instructions as part of the tender documentation, indicating the differences with respect to the maintenance instructions as described in item 3.4.6.1.

3.4.7 Battery water

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

3.4.7.2 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.

3.4.8 Accessories

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

3.4.8.2 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.

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

3.4.9 Inter-row connectors

When specified in schedule A, the tenderer shall make inter-row connectors available which shall be suitable for use on the offered cells.

3.4.10 Safety signs

When specified in schedule A, the tenderer shall make safety signs available that comply with the requirements of240-56362221, Standard for safety signs used in DC applications.

3.4.11 Equipment performance

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

3.4.11.1 Number of years that offered equipment has been in service;

3.4.11.2 Customers, indicating units employed, and their contact information;

3.4.11.3 Environmental conditions where such equipment are installed;

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

3.4.12 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.

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

1) Cell type,
2) C5 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].

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

1) A technical manual which covers handling –, installation –, commissioning –, storage –, maintenance –, and safety instructions.
2) Capacity test results for the applicable battery bank, in the case of wet charged cells. Batch capacity test results will not be accepted.

3.4.13 Tools

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

3.4.14 Spares

3.4.14.1 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.

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

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

3.4.14.4 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: 170 spares of each cell type delivered.

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

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

3.4.14.7 Spare cells and other items shall be available for a period of at least 10 years after the end of contract.

3.4.15 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.

3.4.16 Warranty requirements

3.4.16.1 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.

3.4.16.2 A second prorated OEM warranty of at least an additional 3 years 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.

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

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

3.4.17 Local support

3.4.17.1 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) within 2 weeks.

3) The replacement of faulty cells.

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

3.4.18 Disposal

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

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

3.4.18.3 Processes shall be in place to ensure the following:

1) Collection of redundant cells from the Eskom sites.

2) Full preparation of the cells, ie emptying of electrolyte, crating of cells or wrapping of cells on pallets for transport.

3) Collection of electrolyte from the Eskom sites.

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

3.4.19 Equipment limitation

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

3.5 Ancillary equipment

3.5.1 Maintenance equipment

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

1) Jug,
2) Funnel,
3) Top-up bottle,
4) Anti-corrosion lubricant,

3.5.1.2 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 yellow front cover shall be used for nickel cadmium 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 chipboard 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 contents 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), “NICKEL CADMIUM 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.
15) The log sheets shall be in accordance with 240-118705836, Maintenance of Batteries.

3.5.2 Personal protective equipment

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

1) Apron,
2) Face shield, and
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 cabinets

3.5.4.1 General

1) This specification makes provision for different battery cabinets for use in different Eskom Divisions.

2) In the Distribution Division two types of battery cabinets are used, namely a top drawer cabinet (see Figure 1) and a standalone cabinet (see Figure 2). It should be noted that the standalone cabinet shall be default and that top drawer cabinets shall only be used when space is a constraint.

3) The door panel of the battery charger in the top drawer battery cabinet shall be hinged so as to make access to the battery charger as easy as possible.

4) A battery cabinet hood with extra ventilation along the sides of the hood shall be provided.

5) Both types of cabinets shall have ventilation holes along all the door panels, including the battery charger door panel. There shall, if required, only be ventilation on the side panels located at the top of the battery enclosure (see Figure 1 and Figure 2), this is to ensure structural integrity and optimum ventilation of the battery cabinet.

6) The battery cabinet layout drawings used in the Generation Division are indicated in Annex A and Annex B of this specification. The supplier shall develop detail designs, with drawings, suitable for the offered cabinets. All maximum dimensions shall be strictly adhered to.

7) No isolation point shall come forth inside the battery cabinet.

8) All sharp edges shall be removed from any cabinet part to safeguard installation staff from cuts and abrasions.

9) The complete battery cabinet with the door closed shall have an IP rating of IP31 in compliance with SANS IEC 60529, Degrees of protection provided by enclosures (IP Code).

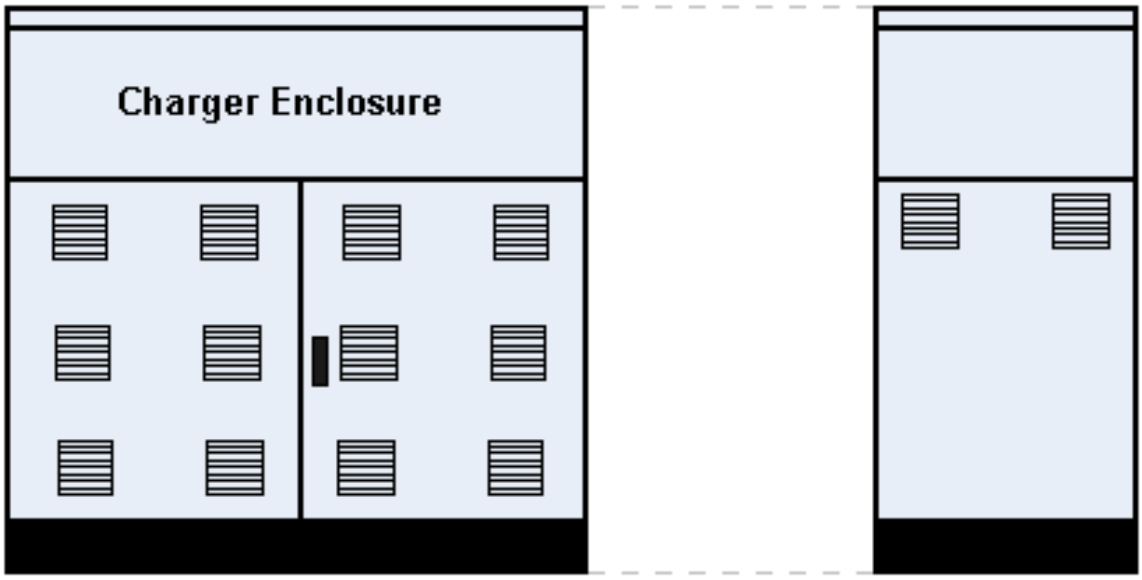


Figure 1: Top Drawer Battery Cabinet

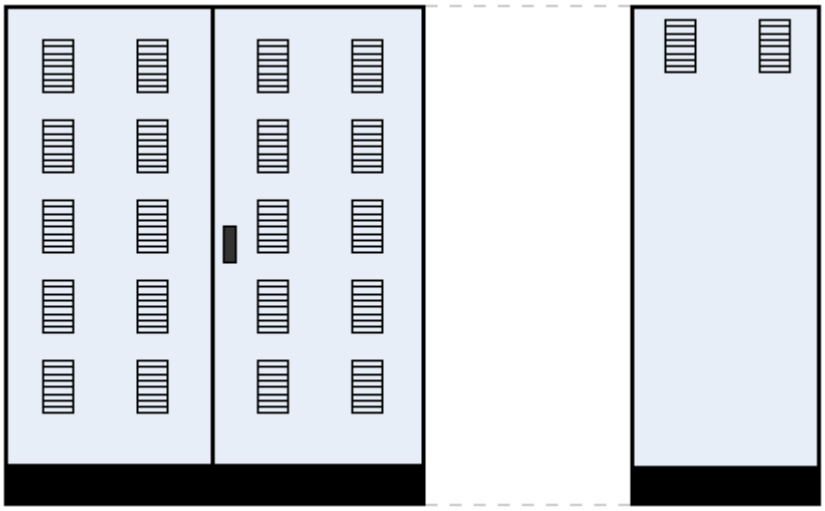


Figure 2: Standalone battery cabinet

3.5.4.2 Cabinet body

1) The cabinet body shall be constructed from mild steel with a thickness of 1.6mm.

2) The maximum width and depth of both battery cabinet types shall respectively be 1800mm and 750mm.

3) The maximum height of the top drawer and standalone cabinet shall be 1300mm and 1850mm respectively. Any deviations from these dimensions shall be approved by Eskom.

4) The continuity between any part of the cabinet and the earth bar shall not exceed 0.1 ohms.

5) The sheet metal and other fixtures that are bolted together shall be done, where possible, by welded studs and bolts.

6) Each separate plate, door or loose steel construction that is bolted together shall be bonded to the earth bar / stud. Unless indicated otherwise, bonding shall be achieved by way of 12mm² tin-plated copper earthing braid.

7) An earthing stud fitted with a spring or serrated washer, plain washer and the fastening nut shall be provided at each gland plate.

8) There shall be a removable stainless steel tray at the bottom of the cabinet which will catch up any liquid which leaks from the batteries. This tray shall be capable of holding at least 30% of the electrolyte contained in the cabinet without leaking. There shall be access from the front of the cabinet to remove the tray after removing the cabinet kick plates (plinth).

9) The cabinet plinth shall have a minimum height of 100mm. The plinth sides shall have mounting holes at the front and the back to bolt the cabinet to the floor.

10) Back to back battery cabinets can be specified and shall be fitted with a 1.5hrs fire barrier between the two battery cabinets.

3.5.4.3 Cabinet doors

1) All the cabinet doors shall be constructed from mild steel with a thickness of 2mm.

2) The doors shall be sturdy and rest on sturdy pivots that shall support the full weight of the door and shall under no circumstances be loosened by frequent opening and closing of the doors.

3) Doors shall only be removable by use of tools i.e. spanners.

4) The doors shall be provided with a 3 point cabinet lock which shall be of the lever type.

5) Each door shall have an earthing stud fitted at the bottom rear corner which is closest to the cabinet door hinge. The stud shall be fitted with a spring or serrated washer, plain washer and the fastening nut.

6) The door shall be bonded to the bottom gland plate or earth stud by way of a 12mm² tin-plated copper earthing braid.

7) Battery cabinets can be specified with front and rear access doors.

3.5.4.4 Cabinet ventilation

1) The doors shall have extruded air vents (louvers) along the length to provide for sufficient ventilation through the battery cabinet and prevent the build-up of hydrogen inside the cabinet. A mesh shall be provided on the inside of the air vents to prevent ingress of insects. The ventilation of the substation or building hosting the battery cabinet should also be evaluated to ensure that the hydrogen released will be diluted and no build-up cab occur.

2) During charging hydrogen is released from the batteries as a result of electrolysis of the battery water. Sufficient ventilation of the battery cabinet shall be ensured by the provision of ventilation louvers.

3) In accordance with the requirements of SANS 10119, Reduction of explosion hazards presented by electrical equipment — Segregation, ventilation and pressurization, the hydrogen concentration limit inside the battery cabinet shall be maintained below 0.8%.

4) Cabinets can be equipped with hydrogen detection sensors (where required):

   i) Hydrogen detection shall be located in the middle of the top right door panel

   ii) The equipment shall have an audible and visible alarm should the hydrogen levels exceed 2%

   iii) The visible alarm shall be above the warning signs.

   iv) The detector shall be capable of detecting hydrogen concentrations regardless of the background gas

   v) The detector shall have two normally open and two normally close contacts for indication purposes

5) The minimum ventilation shall be calculated as shown in Annex D.

6) If the required natural ventilation cannot be obtained, forced ventilation shall be used venting the cabinet directly to a safe area.

7) The effectiveness of the forced ventilation must be monitored. If the ventilation is not fully operational the failure of the forced ventilation must alarmed and the boost and/or equalise charging disabled.

8) The battery cabinet shall be classified based on the principles stipulated in 240-56176113, Classification of battery rooms.

9) If forced ventilation cannot achieve the required ventilation then the battery cabinet shall be zoned as per SANS 10108.

3.5.4.5 Forced Ventilation

One of the following solutions may be used for forced ventilation (in cases where hydrogen evolution is founded by inspection to be excessive and above safe levels):

1) Solution 1: Extraction Fans

   i) The fan shall extract air out of the cabinet. The inlet air into the cabinet shall have louvers as specified. These louvers shall be fitted with replaceable filters

   ii) The fans shall get their supply from the same supply feeding the UPS or Charger

iii) There shall be an audible and visual alarm indicating when the extraction fan is out of operation and ventilation failure.

iv) The boost and/or equalise charge facility will be disabled during ventilation failure.

v) The fans shall be of type ‘e’ as per SANS 60079-7.

vi) For rooms containing the battery cabinet with poor natural ventilation read NOTE 2.

2) Solution 2: HVAC

i) The HVAC shall blow temperature controlled air into the cabinet

ii) The HVAC filters shall filters shall limit airborne particles greater than 1 micron from entering the battery cabinet

iii) The HVAC shall have inputs 100mm above the top battery of each battery rack

iv) The air shall then escape from the cabinet via the louvers.

v) The air temperature shall be maintained between 23˚C and 27 ˚C

vi) There shall be an audible and visual alarm indicating when the HVAC is out of operation

vii) The boost and/or equalise charge facility will be disabled during ventilation failure

viii) The HVAC shall be type ‘e’ as per SANS 60079-7

ix) For rooms containing the battery cabinet with poor natural ventilation read NOTE 2.

NOTE 2: Natural ventilation is only permitted where the cabinet are located in a well ventilated area, and the area ventilation meets the requirements of SANS10108, otherwise forced ventilation shall be used with a duct venting the hydrogen to the outside of the building. The ducting shall vent the hydrogen above the highest point of the building. Appropriate measures shall be taken to ensure no water and dust will ingress via this ducting.

3.5.4.6 Cabinet heating (where required)

1) Cabinet heating and controller shall be provided to control the temperature between 10˚C and 20˚C.

2) The battery charger needs to be specified in 240-53114248, Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies with heater power supply circuits provided on the input of the charger.

3) Heater elements shall be limited to 500W elements.

4) Additional, independent from temperature controller over temperature protection must be provided.

3.5.4.7 Cabinet interior

1) Fixed steps shall be provided in the inside of the cabinet for the installation of the battery cells.

2) The top drawer battery cabinet shall have a single tier of steps with a maximum of 5 steps. There shall be no opening between the battery enclosure and the charger enclosure.

3) The standalone battery cabinet shall have a top and bottom tier of steps with a maximum of three steps on each tier.

4) The top tier steps of a standalone cabinet shall be designed to allow the free movement of air from the lower tier upwards to the upper air vents and prevent the build-up of hydrogen above the bottom tier cells.

5) The minimum distance (clearance) between the lowest point of the top tier and the highest point of a cell on the highest level of the bottom tier shall be at least 250mm in order to allow for easy and safe maintenance to be executed.

6) The steps height shall be such that the minimum or applicable electrolyte level of the cells is visible for maintenance purposes.

7) The steps shall be reinforced to carry the cells safely.

8) Washing lines shall be provided diagonally along the sides of the cabinet above the steps to facilitate the fastening of the battery wiring.

9) To prevent electrolyte flowing from the upper battery rack over the batteries in the lower rack of a standalone battery cabinet, the steps of the upper rack shall resemble Annex C, Figure 2. This shall however not limit the air flow.

10) Two appropriately marked stand-off insulators (One red and one blue) for the connection of the incoming battery cables from the battery charger shall be provided.

11) The battery cables, inside the battery cubicle, shall terminate on these stand-off insulators. The thread of the stand-off insulators shall be long enough to allow for the connection of an additional lug, washer, spring washer and bolt.

12) An insulating barrier plate shall be mounted between the positive and negative stand-off insulators in order to eliminate inadvertent short circuits during connections.

13) For both cabinet types a set of stand-off insulators shall be located at the inner top left hand side panel to allow for top cable entry termination.

14) For stand-alone battery cabinets a set of stand-off insulators shall be located at the inner left hand side panel, below the top tier lowest step to allow for bottom cable entry termination.

3.5.4.8 Electrical Cabinet Inclusions

1) When requested, there shall be a CFS mounted on the left side panel of the battery cabinet. The CFS shall have two normally open and two normally closed contacts which will provide feedback to the UPS / charger.

2) There shall be air to air DC bushings mounted on the left side panel. These bushings provide electrical entry from the outside into the battery cabinet.

3) Items mentioned in above shall be enclosed in a segregated enclosure mounted to the left side of the battery cabinet.

   i) The body and door of the enclosure shall be constructed from and treated with the same materials and methods as the rest of the battery cabinet.

   ii) The enclosure shall have a single galvanized gland plate constructed from 2mm mild steel.

   iii) The gland plate shall be located at the bottom of the enclosure.

   iv) The gland plate shall be pre-punched with holes for supply cables and indication cable.

3.5.4.9 Optional accessories

An option will be provided whereby the cabinet is fitted and supplied with a plinth-mounting angle iron capable of supporting 350kg. The plinth-mounting angle iron is used to support the inspection plate covering the trench at the back of the cabinet. M10 bolts shall be used to fix the angle iron.

3.5.4.10 Corrosion protection

1) The cabinet shall be powder coated. Before any powder coating can take place it is very important to ensure that there is no oil present. Therefore the material surface shall be degreased before powder coating.

2) Powder coating shall be conducted as specified in SANS 1274.

3) The cabinet shall be powder coated to type 4 as specified in SANS 1274.

4) The battery gland plate shall be designed to limit the effect of induced currents. The gland plates shall be pre-punched according to information provided by Eskom when called for and the punched holes plugged with grommets.

5) The bottom gland plate shall allow for a minimum 300mm clearance from the bottom. The gland plates shall be galvanised or manufactured from aluminium or stainless steel.

6) The paint colour of the cabinet plinth shall be black as specified in SANS 1091. All other painted components shall be Light Grey (G29) as per SANS 1091.

7) An Alkaline/Acid resistant protective coating, depending on the type of battery to be housed, shall be applied to the steps and diagonally along the sides of the cabinet up to a height of 300mm above the highest battery in the cabinet. This coating shall be applied as per manufacturer's instruction and shall last for the lifetime of the battery cabinet.

3.5.4.11 Nameplate

Each cubicle shall have a stainless steel or anodized aluminium plate on which the following information as a minimum is engraved:

1) Manufacturer name and contact details,

2) Year of manufacture,

3) Cabinet type,

4) Cabinet SAP Number,

5) Contract Number and Purchase order number,

6) Maximum number of cells and type of cells,

7) Power frequency withstand voltage,

8) Ex rating,

9) IP rating,

10) Electrical motor rating and specification,

11) Extraction fan details and rating.

3.5.4.12 Prototype

A prototype of each item shall be supplied to Eskom. Eskom shall inspect / test the prototype before acceptance and registration of the products on the List of Accepted Products where applicable.

3.5.4.13 Tests

The cabinet metal parts that are exposed shall be checked that they have a reading of 0.1 ohms or less between each part and the battery cabinet earth stud. The test certificate shall be kept on file with the supplier for the validity of the product on the List of Accepted Products or contract. A copy of this certificate shall be supplied with each order.

Product tested (Stipulate item no. as per contract)	Name and Surname of the test person	Date of test	Signature	Continuity test (Detail the highest reading in ohms)	Item Serial No.
Item 1.1	Jack Example	07/07/2007		0.08 ohms	12345
Type of Test Meter:			Serial No.		
Date of last meter accuracy test:			Institution performing meter test:		

3.5.4.14 Labelling

1) A common alpha-numeric designation system for the codification of all items of plant and its components is used for the whole power station.

2) The Contractor is fully familiar with the standards and concepts of the AKZ/KKS system as applied by the Employer.

3) The Contractor codifies all plant and its components in his supply for which the Works Information and Contract Data indicates he is responsible.

4) The specific AKZ/KKS-code of each cabinet appears on all documents, drawings (i.e. general arrangements, schematic diagrams, etc), and labels for the cabinets and its components.

5) The Contractor provides a list of all AKZ/KKS-codes used in accordance with standard documentation.

6) The relevant AKZ/KKS-code is included on the label according to the required format, together with plant description and classification code.

7) The allocation of all codes is accepted by the Project Manager. The Contractor ensures that the code is applied in a uniform and consistent way and that all codes allocated are unique.

3.5.4.15 Signage

1) The safety signs shall be placed on the outside, in the middle of the right hand door panel. The top of the sign shall be 1500mm from the bottom of the base of the cabinet. The sign shall not cover any of the ventilation louvers.

2) The warning signs shall be non-reflective and made from acceptable plastic or metal no less than 1mm thick. All the warning signs mounted to the cabinet shall comply with SANS 1186-1.

3) Warning signs shall be mounted to the cabinet via nuts bolts and washers as specified in SANS 1186-1 (C4).

3.5.4.16 Packaging

1) The battery cabinet shall be packed in a high specification impact resistant corrugated cardboard box and/ or a wooden crate. The packaging shall be waterproof, and shall protect the contents from reasonable transport related wear and tear from the supplier's works to the end site. The packaging shall be clearly marked as indicated below in section 3.7.

2) The cabinet locks shall be removed when shipped and fixed firmly inside the cabinet in a separate plastic bag. The reason for this requirement is because it was found that the locks damage the cabinets during transport.

3.5.4.17 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 the national calibration service.

3.6.1.2 Eskom shall at its discretion decide 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 tenderer to proof compliance with the required specifications in cases where the equipment complies with a similar specification.

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

3.6.1.5 Automated test results are to include the following data:

a) Cell voltages logged date and time stamped.

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

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

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

3.6.2 Electrical and mechanical tests

The electrical and mechanical tests as stated in SANS 62259: 2005, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Nickel-cadmium prismatic secondary single cells with partial gas recombination shall apply.

3.6.3 Test certificates

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

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

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, marking and transport

3.7.1 Packaging

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.

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.

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

5. Revisions

Date	Rev	Compiler	Remarks
May 2020	3	C van Zyl	Informative reference updated. Section 2.7. updated to indicate that “Section 3.5.1.2 of this document replaces the contents related to logbooks used for Nickel Cadmium batteries in 240-76627823, Lead Acid and Nickel Cadmium Battery Logbooks Standard” General requirements updated on automated test results and OEM distribution formal agreements/appointment Cell container revised to single moulded jars. No welded seams will be accepted Electrolyte reserve - changed from reference temperature to environmental temperatures Under environmental conditions new storage temperatures added Technical Manuals to include storage instructions. Batch capacity test results will not be accepted. Spare cells and other items shall be available for a period of at least 10 years after the end of contract Warranty requirements changed to at least 2 years full warrantee with additional 3 years pro-rata warranty Reference to standards updated throughout document Type test certificates and reports revised Logsheets to be supplied as per 240-118705836, Maintenance of Batteries standard Battery cabinets requirements updated. Added requirement that all battery capacity discharge test conducted will be automated in terms of data captured.

Date	Rev	Compiler	Remarks
June 2015	2	C van Zyl	Document reformatted into new template. Updated to reflect changes in general requirements References to SANS 1632-2-2005 removed as the document has been withdrawn Added the need for direct communication channels with the OEM and the OEM letter of accreditation requirements Removed “The manufacturer will be expected to provide a warranty of at least 12 years”. Added “A second prorated warranty of at least an additional 4 years shall be submitted”. Added “All Nicad cells to be given a fully documented commissioning charge just before or after installation at site”. Added the requirements of the Nicad 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 240-53114234, Battery cabinet standard, as a section.
Mar 2013	1	M van Staden	Document reviewed as part of the TDAC process.

6. Development team

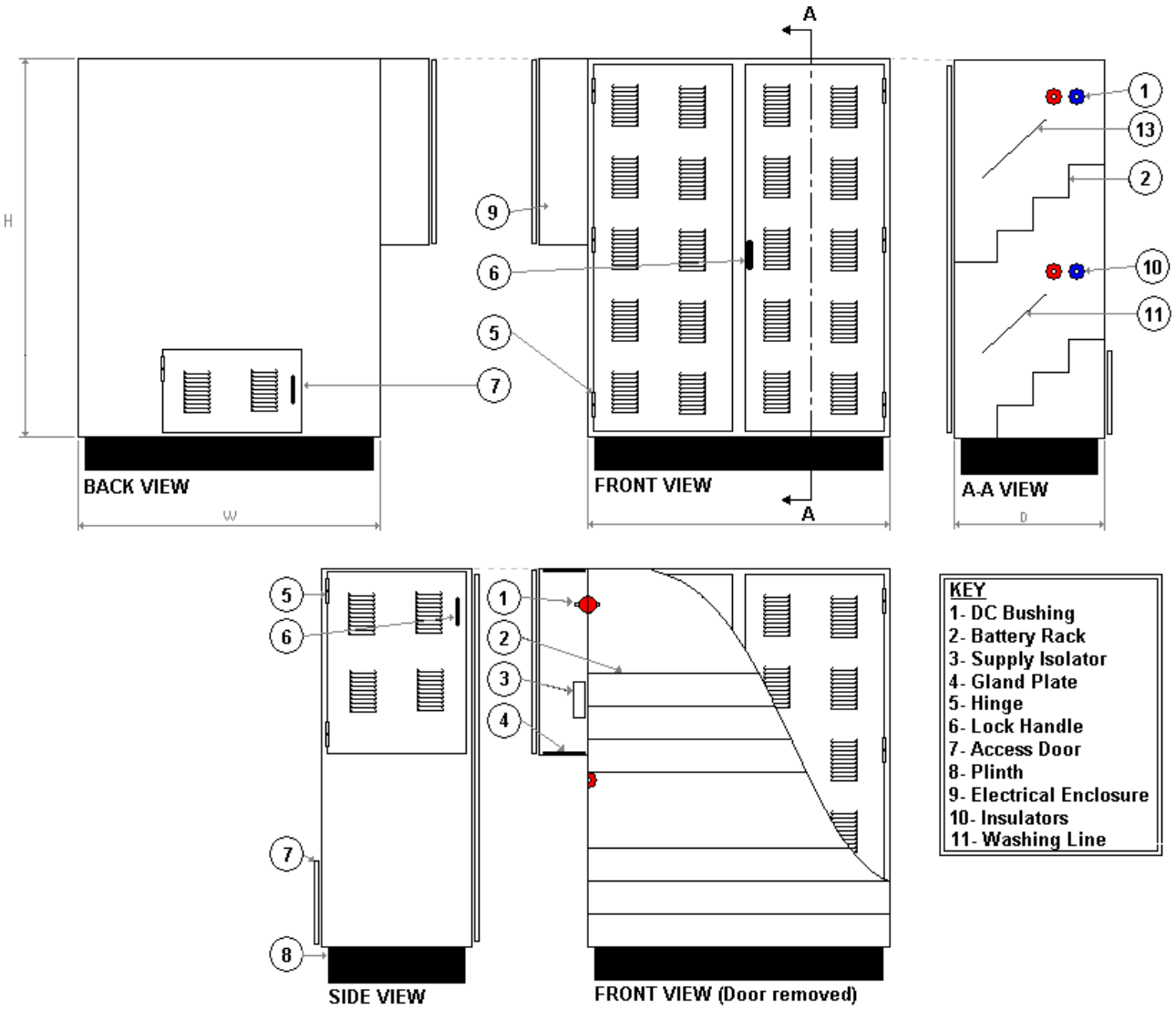
The following people were involved in the development of this document:

- Thomas Jacobs
- C van Zyl

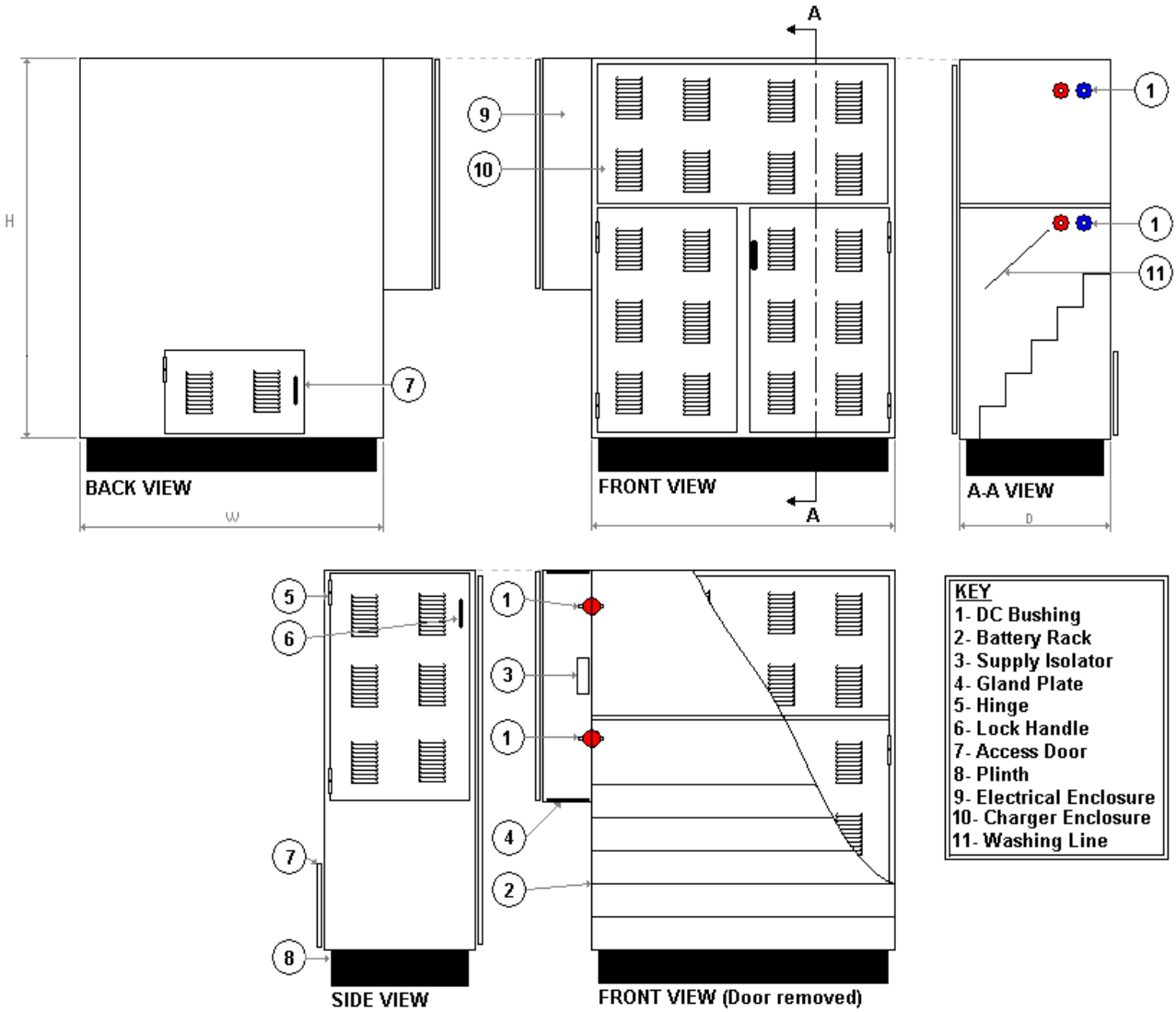
7. Acknowledgements

Not applicable.

Annex A – Standalone battery cabinet layout drawing



Annex B – Top drawer battery cabinet layout



Annex C – Upper rack design

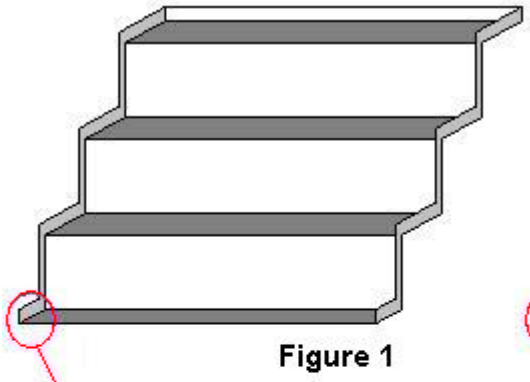


Figure 1

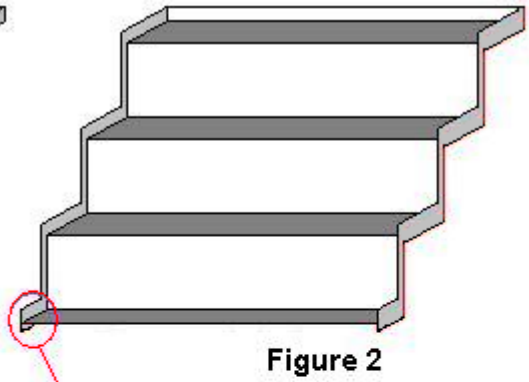
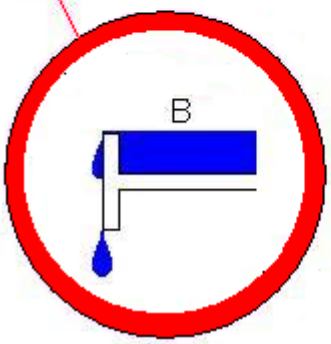


Figure 2



Annex D – Ventilation calculation

STEP 1

The maximum hydrogen development must firstly be calculated which is occurs during over charging. This can be calculated using the following:

$$V_{HYDROGEN} = 0.00045 \times N \times I$$

Where:

V is the volume (in m³ at standard atmospheric pressure) of hydrogen liberated per hour

0.00045 is a constant in cubic meter per ampere (m^3/A)

N is the number of **cells**

I is the overcharging current in ampere (A)

NOTE 1: In the case of vented (flooded) cells, the current I should be that value declared by the manufacturer at the maximum boost voltage to be used across the battery.

NOTE 2: In the case of valve-regulated cells, the current I should be that value declared by the manufacturer as I_E, which is determined from an overcharge gas emission test at 2,4 V per cell.

NOTE 3: If a valve-regulated cell has not been subjected to a gas emission test, the current I should be that value declared by the manufacturer at an overcharge voltage of 2,4 V per cell.

This volume obtained in the above equation can be expressed in % by using the following equation:

$$S = \frac{V_{HYDROGEN}}{V_{CABINET} - V_{BATTERIES}}$$

where

S is the percentage hydrogen development in the cabinet

$V_{CABINET}$ is the Volume of air with in the cabinet

$V_{CABINET}$ is the volume of one cell multiplied by the number of cells contained in the cabinet

NOTE 4: The recommended maximum volume fraction of hydrogen in air is 0.8%.

Example

A battery of 120 cells, that has an overcharge current, I, equal to 5 A, in a cabinet of dimensions 2,0 m × 1,0 m × 3,0 m, the batteries have a total volume of 1,0 m3.

The volume of hydrogen liberated per hour will be

$$V_{HYDROGEN} = 0.00045 \times (120) \times (5)$$

$$V_{HYDROGEN} = 0.27 m^3$$

Thus 0.27 cubic meters of hydrogen is released ever hour during over charging

The volume inside the cabinet is 6 m³.

The volume of the batteries is 1,0 m³.

Therefore, the percentage concentration of hydrogen gas in the room after 1 h of charging would be

$$S = \frac{0.27m^3}{6m^3 - 1m^3}$$

$$S = 5.4\%$$

Thus if there is zero ventilation then the cabinet will accumulate enough hydrogen to cause an explosion (Explosive mixture is between 4% and 75% of hydrogen in air)

STEP 2

In order to maintain the hydrogen level below the recommended 0.8% one must calculate the amount of times the air must be changed over in the hour. This can be done by the following calculation

$$\Delta Air = \frac{S}{0.8\%}$$

Where

ΔAir is the rate at which the air in the cabinet must be changed per hour within the cabinet

The required flow rate can then be determined by the following calculation:

$$Q = (\Delta Air)(V_{CABINET} - V_{BATTERIES})$$

Where

Q is the required flow rate in meter per hour m^3/h

Making the assumption that the flow rate through the cabinet will be $0.1m/s$ then the required opening area for adequate air flow will be as shown in the following calculation:

$$A_{OPENINGS} = \frac{2 \times Q}{(0.1m/s)}$$

Example

From the previous example the percentage hydrogen was calculated to be 18.4%. Thus the following can be deduced:

$$\Delta Air = \frac{5.4\%}{0.8\%} = 6.75 times/h$$

thus the air in the cabinet must be replaced 23 times per hour

$$Q = (6.75)(6m^3 - 1m^3) = 33.75m^3/h$$

thus the flow rate out of the cabinet is 115 cubic meters every hour

$$A_{OPENINGS} = \frac{2 \times 33.75m^3/h}{0.1m/s \times 3600} = 0.1875m^2$$

Thus the total area of all the openings is not less than 0.1875m². Half of this area shall be located bellow the lowest step of the upper tier and the other half shall be located above the lowest step of the upper tier.

NOTE 1: Additional ventilation may be added, this calculation is for the minimum requirements

Annex E – Technical Schedules A and B

Stationary vented nickel cadmium batteries

If different battery banks are specified a complete set of technical schedules shall be prepared for each battery bank 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		
	Scope	As specified	
	Recombination technology employed	Yes – SANS 62259:2005	
	Cells condition on delivery	As specified	
	Commissioning and testing	As specified	
	Accessories	As specified	
	Discharge tests results	Yes	
	Maintenance equipment	Yes	
	Safety equipment	Yes	
	Battery cabinets	Yes	
	Terminating devices	Yes	
	Inter-row connectors	Yes	
	Transport	Yes	
	Disposal	Yes	
	OEM technical support	Yes	
	OEM distribution formal agreement / contract	Yes	
3.2	Electrical performance requirements		
3.2.2	Rated capacity	As specified	
3.2.3	Discharge curves and tables	As specified	
3.2.4	Suitability for floating operation	Comply	
	Fully charge state – under float:		
	Voltage/cell [V]	Specify	
	Recommended boost voltage [V]	Specify	
	Recommended equalise voltage [V]	Specify	
	Recommended boost charge frequency	Specify	
	Recommended equalise charge frequency	Specify	
3.2.5	Endurance	Comply	
	Expected life	17 years	
	End-of-life capacity	80%C5	
	Deterioration rate / capacity loss [%Ah/yr]	Specify	
	Number of cycles to 80%C5	Specify	
3.2.6	Charge retention	As specified	

Item	Description	Schedule A	Schedule B
3.2.7	Short-circuit current and internal resistance	Comply	
	Short-circuit current (I_{SC}) [kA] Internal resistance (R_i) [Ω]	Specify Specify	
3.2.8	Tolerance to AC components of the DC supply	Comply	
	Maximum allowable RMS ripple current and effect on battery life [mA] Maximum allowable RMS ripple voltage and effect on battery life [mV] Equipment RMS ripple current [mA] Equipment RMS ripple voltage [mV]	Specify Specify	
3.2.9	Effect of temperature	Comply	
	Effect of temperature on expected battery life Temperature de-rating – Table / Graph	Specify Specify	
3.3	Mechanical requirements		
3.3.1	General	Comply	
	Performance type Resistance to earthquakes	Low No	
3.3.2	Battery cabinets required	Yes – DSP_34-1959	
3.3.3	Terminal posts	Comply	
	Recommended torque levels [Nm]	Specify	
3.3.4	Terminal seals	As specified	
3.3.5	Single moulded containers	As specified	
3.3.6	Cell lids	Comply	
	Maximum internal cell pressure [kPa]	Specify	
3.3.7	Vent plugs	As specified	
3.3.8	Electrolyte reserve	Comply	
	Topping up period [months] Maximum topping period at specified environmental temperature [months] Electrolyte reserve per cell [l] Electrolyte reserve per cell [%]	Specify Specify Specify Specify	
3.3.9	Cell markings and labelling	As specified	
	Barcodes per cell	No	
3.4	Operational requirements		
3.4.1	Environmental conditions		
3.4.1.1	Altitude Relative humidity Lightning	2200m 10% - 85% non condensing High	

Item	Description	Schedule A	Schedule B
3.4.1.2	Outdoor air temperatures: Maximum Daily average Yearly average Minimum	 40°C 30°C 20°C -10°C	
3.4.1.3	Equipment room air temperatures: Maximum Daily average Yearly average Minimum	 50°C 35°C 25°C -5°C	
3.4.1.4	Storage temperatures: Maximum Daily average Yearly average Minimum	 35°C 25°C 20°C -5°C	
3.4.2	Application	As specified	
3.4.3	Charging regimes	As specified	
3.4.4	Hydrogen release data	As specified	
3.4.5	Commissioning procedures accepted	Specify	
3.4.6	Maintenance procedures accepted	Specify	
3.4.7	Battery water: Maximum conductivity [µS/cm] Allowable substance traces	 Specify Specify	
3.4.8	Accessories: Bolts, nuts, washers and connectors	 Yes – As specified	
3.4.9	Inter-row connectors required	Yes – As specified	
3.4.10	Safety signs required	Yes – As specified	
3.4.11	Equipment performance	Specify	
3.4.12	Type Test certificates & reports, drawings and instruction manuals	Supply – As specified	
3.4.13	Tools	Specify	
3.4.14	Spares	Specify	
3.4.15	Training	Specify	
3.4.16	Warranty requirements	Specify	
3.4.17	Local support	Specify	
3.4.18	Disposal	As specified	
3.4.19	Equipment limitations	Specify	
3.5	Ancillary equipment	Comply	

Item	Description	Schedule A	Schedule B
3.5.1	Maintenance equipment required: Jug, Funnel, top-up bottle, Anti-corrosion lubricant Battery logbooks	Yes – As specified Yes – As specified	
3.5.2	Personal protective equipment required: Apron, face shield, gloves	Yes – As specified	
3.5.3	Maintenance equipment rack / cabinet / box	Yes – As specified	
3.5.4	Battery cabinets	Yes – As specified	
3.6	Tests	Comply	
3.6.1	General	Comply	
3.6.2	Electrical and mechanical tests	As specified	
3.6.3	Test certificates	As specified	
3.6.4	Clearance for dispatch	As specified	
3.7	Packaging, labelling, marking and transport	Comply	
3.7.1	Packaging	As specified	
3.7.2	Labelling	As specified	
3.7.3	Transport	As specified	

Annex F – Deviation schedule for Stationary vented nickel cadmium batteries

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost-effective than that specified by Eskom.

Item	Clause	Proposed deviation