

 Eskom	Standard	Technology
---	----------	------------

Title: **LITHIUM IRON PHOSPHATE BATTERIES STANDARD** Unique Identifier: **240-170000103**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**

Documentation Type: **Standard**

Revision: **1**

Total Pages: **22**

Next Review Date: **October 2025**

Disclosure Classification: **Controlled Disclosure**

Compiled by	Approved by	Authorised by
		
<b>Christo van Zyl</b> <b>Senior Technologist</b>	<b>Thomas Jacobs</b> <b>Chief Engineer</b>	<b>Dr Titus Mathe</b> <b>General Manager:</b> <b>Engineering</b>
Date: 17 September 2020	Date: 29 September 2020	Date: 13 October 2020
		<b>Supported by SCOT/SC</b>
		
		<b>Kashveer Jagdaw</b> <b>DC &amp; Auxiliary Supplies SC</b> <b>Chairperson</b>
		Date: 18 September 2020

## Content

	Page
1. Introduction .....	4
2. Supporting clauses .....	4
2.1 Scope .....	4
2.1.1 Purpose .....	4
2.1.2 Applicability .....	4
2.2 Normative/Informative references .....	4
2.2.1 Normative .....	4
2.2.2 Informative .....	4
2.3 Definitions .....	5
2.3.1 General .....	5
2.3.2 Disclosure classification .....	5
2.4 Abbreviations .....	5
2.5 Roles and responsibilities .....	6
2.6 Process for monitoring .....	6
2.7 Related/Supporting documents .....	6
3. Stationary Lithium Iron Phosphate Batteries Standard .....	6
3.1 General requirements .....	6
3.2 Electrical performance requirements .....	7
3.2.1 General .....	7
3.2.2 Rated capacity .....	7
3.2.3 Discharge performance at +25 °C .....	7
3.2.4 Discharge performance at low temperature .....	8
3.2.5 High rate discharge permissible current .....	8
3.2.6 Suitability for floating operation .....	8
3.2.7 Endurance .....	8
3.2.8 Charge retention .....	8
3.2.9 Short-circuit current and internal resistance .....	9
3.2.10 Tolerance to AC components of the DC supply .....	9
3.2.11 Effect of temperature .....	9
3.3 Mechanical requirements .....	9
3.3.1 General .....	9
3.3.2 Battery cabinet .....	9
3.3.3 Containers .....	9
3.3.4 Cell, module and battery pack marking and labelling .....	10
3.4 Operational requirements .....	10
3.4.1 Environmental conditions .....	10
3.4.2 Application .....	11
3.4.3 Charging regimes and battery management system .....	11
3.4.4 Venting of gases .....	12
3.4.5 Commissioning .....	12
3.4.6 Maintenance .....	12
3.4.7 Accessories .....	12
3.4.8 Inter-row connectors .....	12
3.4.9 Safety signs .....	13
3.4.10 Equipment performance .....	13

**ESKOM COPYRIGHT PROTECTED**

3.4.11	Type test certificates, drawings and instruction manuals .....	13
3.4.12	Tools .....	13
3.4.13	Spares .....	13
3.4.14	Training .....	14
3.4.15	Warranty requirements .....	14
3.4.16	Local support .....	14
3.4.17	Disposal .....	14
3.4.18	Equipment limitation .....	15
3.5	Ancillary equipment .....	15
3.5.1	Maintenance equipment .....	15
3.5.2	Battery cabinets .....	15
3.6	Tests .....	15
3.6.1	General .....	15
3.6.2	Electrical and mechanical tests .....	15
3.6.3	Test certificates .....	15
3.6.4	Clearance for dispatch .....	16
3.7	Packaging, labelling, marking and transport .....	16
3.7.1	Packaging .....	16
3.7.2	Labelling .....	16
3.7.3	Transport .....	16
4.	Authorisation .....	17
5.	Revisions .....	17
6.	Development team .....	17
7.	Acknowledgements .....	17
	Annex A – Technical Schedules A and B .....	18
	Annex B – Deviation schedule for stationary lithium iron phosphate (LFP) batteries .....	22

## Tables

Table 1: Discharge performance at +25 °C ± 5 °C .....	7
Table 2: Discharge current values for high rate permissible test .....	8

## **1. Introduction**

This standard contains information regarding the technical requirements of stationary lithium iron phosphate (LiFePO<sub>4</sub>) batteries, 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, offloading, erection, commissioning and decommissioning of lithium iron phosphate (LFP) cells, its accessories and ancillary equipment.

#### **2.1.1 Purpose**

The document addresses the standard documented technical specifications to be used when evaluating lithium iron phosphate (LFP) batteries during tender submissions in line with the Eskom Holdings SOC (Ltd) requirement.

#### **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 60086-4:2016, Safety of lithium batteries
- [6] IEC 62619:2017, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- [7] IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications
- [8] 240-56356510, Definitions of Terms Applicable to DC Emergency Supplies Standard

### **2.2.2 Informative**

- [9] 240-61182045, Maintenance Engineering Standard for batteries and chargers
- [10] 240-89797258, The safe handling, transportation and disposal of cells, batteries and electrolyte
- [11] 240-56177186, Battery Room Standard
- [12] 240-56176852, Essential Power Supplies for Power Stations Standard
- [13] 240-118870219, Standby power systems topology and autonomy for Eskom
- [14] 240-56362221, Standard for safety signs used in DC applications

**ESKOM COPYRIGHT PROTECTED**

## 2.3 Definitions

### 2.3.1 General

Definition	Description
<b>Battery management system</b>	Electronic system associated with a battery, which monitors and/or manages its state, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life and has the functions to cut off in case of overcharging, overcurrent and overheating.
<b>DC system</b>	Consists of a battery charger, which is connected in parallel to a standby battery bank for the provision of DC power to the required load equipment.
<b>End-of-discharge voltage</b>	Specified closed circuit voltage at which a discharge of a cell or battery is terminated.
<b>Lithium battery</b>	Unit which incorporates one or more secondary lithium cells and which is ready for use. It incorporates adequate housing and a terminal arrangement and may have electronic control devices.
<b>Lithium cell</b>	Single cell whose electrical energy is derived from the oxidation and the reduction of lithium. It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.
<b>Nominal voltage</b>	Suitable approximate value of voltage used to designate or identify a cell, or a battery.
<b>Rated capacity</b>	Quantity of electricity C <sub>5</sub> Ah (ampere hours), declared by the manufacturer, which can be delivered by a fully charged single cell to a specified end-of-discharge terminal voltage during a specified 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
<b>AC</b>	alternating current
<b>Ah</b>	ampere hour
<b>BMS</b>	battery management system
<b>C<sub>5</sub></b>	five-hour rated capacity
<b>DC</b>	direct current
<b>LiFePO<sub>4</sub></b>	lithium iron phosphate
<b>LFP</b>	lithium iron phosphate (industry norm)
<b>OEM</b>	original equipment manufacturer
<b>PPE</b>	personal protective equipment
<b>SANS</b>	South African National Standards
<b>SoH</b>	State of health

**ESKOM COPYRIGHT PROTECTED**

## **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 and Auxiliary Supplies Study Committee shall ensure that document is always maintained and updated.

## **2.7 Related/Supporting documents**

Not applicable

# **3. Stationary Lithium Iron Phosphate Batteries Standard**

## **3.1 General requirements**

Unless otherwise specified, the following is required:

- a) The scope shall be for the manufacture, delivery to site, offloading, erection, commissioning and decommissioning of LFP cells to Eskom stores or sites.
- b) The safe operation of each battery assembly shall be verified and certified by a SANAS/ILAC-accredited laboratory according to the requirements set out in IEC 62619. Certified copies of test certificates and reports shall be provided.
- c) For a battery assembly consisting of multiple series connected single cells or multiple series and/or parallel connected cell blocks, all the relevant test results and certification for the single cells shall be provided according to the requirements set out in IEC 62619.
- d) The battery assembly shall be supplied in a charged state with test results as indicated in Schedule A.
- e) The cells shall be commissioned and their capacity tested with automated test results by the manufacturer/supplier at his works before being transported to the required destination.
- f) Automated test results are to include the following data.
  - Cell voltages logged date and time-stamped.
  - Battery bank voltage with discharge current logged for the duration of the discharge test.
  - These results shall be supplied in the original data logging reporting format.
  - This information shall be supplied in hard copy and be available in electronic format.
- g) All battery banks shall be supplied complete with all necessary intercell connectors, nuts, bolts, washers, anti-corrosion lubricant, cell numbers and capacity test reports.
- h) Each battery assembly shall have an integrated battery management system (BMS).
- i) When required, the supplier shall also be responsible for the provision of maintenance equipment, safety equipment, battery cabinets, terminating devices and inter-row connectors. The supplier shall also provide transport and disposal of used cells, of which the requirements shall be stated below.
- j) 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.
- k) OEM acknowledgement of certification/accreditation of the supplier should contain in detail:
  - Formal Distribution agreement/appointment should include duration and scope of contract.
  - Technical support offered.
  - Warranties offered via OEM directly to Eskom.

**ESKOM COPYRIGHT PROTECTED**

- These agreements/contracts must be on a formal OEM document.

## 3.2 Electrical performance requirements

### 3.2.1 General

Electrical tests are applied to cells and/or batteries. If the battery is divided in smaller units, the unit can be tested as the representative of the battery. The manufacturer shall clearly declare the tested unit. The manufacturer may add, to the tested unit, functions which are present in the final battery.

The manufacturer can use “cell block(s)” instead of “cell(s)” at any test that specifies “cell(s)” as the test unit in this document. The cell manufacturer shall clearly declare the test unit for each test.

### 3.2.2 Rated capacity

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, ambient temperature and end-of-discharge voltage.

**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 IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.

**3.2.2.2** Unless otherwise specified, the rated capacities shall be specified at a reference temperature of 25 °C, over a discharge period of 5h to a final end-of-discharge voltage as declared by the manufacturer.

**Note:** All tests are performed with the same final voltage value as declared by the manufacturer.

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

### 3.2.3 Discharge performance at +25 °C

This test verifies the rated capacity of a cell or battery at 25 °C ± 5 °C.

Step 1 – Prior to charging, the cell or battery shall be discharged at 25 °C ± 5 °C at a constant current of 0,2  $I_t$  A, down to a specified final voltage. Cells or batteries shall then be charged using the method declared by the manufacturer.

Step 2 – The cell or battery shall be stored in an ambient temperature of 25 °C ± 5 °C, for not less than 1 h and not more than 4 h.

Step 3 – The cell or battery shall then be discharged at 25 °C ± 5 °C to the final voltage as specified by the manufacturer.

**Table 1: Discharge performance at +25 °C ± 5 °C**

Discharge conditions		Minimum discharge capacity		
Rate of constant current	Final voltage	Discharge rate type (see Table 2)		
[A]	[V]	E	M	H
0,2 $I_t$	As declared by the manufacturer	100 % $C_5$ Ah	100 % $C_5$ Ah	100 % $C_5$ Ah
Five cycles are permitted for this test, which shall be terminated at the end of the first cycle which meets the requirement.				

**3.2.4 Discharge performance at low temperature**

- 3.2.4.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply. This test verifies the discharge performance at low temperature of the cell or battery.
- 3.2.4.2** The manufacturer shall indicate in Schedule B the temperature at which a capacity of not less than 70% of the rated capacity can be achieved.

**3.2.5 High rate discharge permissible current**

- 3.2.5.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply. This test is to evaluate the ability of an “H” or “M” type cell or battery to withstand high currents. No fusing, no deformation of the cell or battery case, and no leakage shall be observed. In addition, the cell or battery voltage during the discharge shall show no discontinuity. The capacity of the cell or battery shall not be less than 95% of the rated capacity.

**Table 2: Discharge current values for high rate permissible test**

Discharge rate type	Rate of constant current
E (low rate)	N/a
M (medium rate)	Minimum 6 I <sub>t</sub> A
H (high rate)	Minimum 20 I <sub>t</sub> A

- 3.2.5.2** The manufacturer shall indicate in Schedule B compliance with the minimum-rated current discharge test.

**3.2.6 Suitability for floating operation**

- 3.2.6.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.
- 3.2.6.2** The manufacturer shall indicate, in Schedule B, the actual voltage per cell in the fully charged floating state.

**3.2.7 Endurance**

- 3.2.7.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.
- 3.2.7.2** The expected life of the cell or battery shall be at least 15 years under the conditions as specified in 3.4.1.
- 3.2.7.3** The expected end-of-life capacity shall be not less than 80% C<sub>5</sub>.
- 3.2.7.4** The manufacturer shall indicate, in Schedule B, the expected rate of deterioration (capacity loss) over the life of the cell or battery under the conditions as specified in 3.4.1.
- 3.2.7.5** The manufacturer shall indicate, in Schedule B, the number of cycles to 80% DoD.

**3.2.8 Charge retention**

The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.

- 3.2.8.1** The charge retention value of the discharged capacity after 28 days of storage at an ambient temperature of 25 °C ± 5 °C shall not be less than 85% of the rated capacity
- 3.2.8.2** The charge recovery value by a subsequent recharge done and resting for not less than 1 h and not more than 4 h shall not be less than 90% of the rated capacity.

**ESKOM COPYRIGHT PROTECTED**



The manufacturer shall indicate, in Schedule B, the obtained charge retention,  $C_R$ , and the subsequent charge recovery value as a percentage of the initial capacity,  $C_a$ .

### **3.2.9 Short-circuit current and internal resistance**

**3.2.9.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.

**3.2.9.2** The manufacturer shall indicate, in Schedule B, the value of the short-circuit current,  $I_{sc}$ .

**3.2.9.3** This test determines the internal resistance of a secondary lithium cell or battery. The alternating current (AC) method is only applied for the cell. The direct current (DC) method is applied for the cell and for the battery. The manufacturer shall indicate, in Schedule B, the value of the internal resistance,  $R_{dc}$ , at the reference temperature of 25 °C.

### **3.2.10 Tolerance to AC components of the DC supply**

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

**3.2.10.2** 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 240-53114248, Specification for Thyristor and switch mode chargers, AC/DC to DC/AC converters and inverter/uninterruptible power supplies, shall be applicable.

### **3.2.11 Effect of temperature**

**3.2.11.1** The manufacturer shall indicate, in Schedule B, the effects of temperature on the expected battery life.

**3.2.11.2** 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 derating 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 LFP cells are required. The purchaser shall indicate whether it is E-, M-, or H-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 3.5.2.

### **3.3.3 Containers**

**3.3.3.1** The manufacturer shall indicate, in Schedule B, the construction materials used in the manufacture of the cell/battery bank containers.

**3.3.3.2** The manufacturer shall indicate the cell construction as to cylindrical, prismatic or pouch.

**3.3.3.3** The manufacturer shall indicate the orientation of the cells in operational use.

**3.3.3.4** The manufacturer shall confirm that the battery modules have been constructed using flame retardant materials.

### **3.3.4 Cell, module and battery pack marking and labelling**

**3.3.4.1** The requirements of IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.

**3.3.4.2** The following options are allowed:

- If there are designations on a battery pack, designations are not necessary on the module and cell;
- If there are designations on a module, designations are not necessary on the cell; and
- For individual cells, designations on each of the cells are required.

**3.3.4.3** Information relevant to safety recommendations as required by local, national, or international regulations shall be marked on each cell or battery module/pack.

**3.3.4.4** Each cell or battery module/pack that is installed or maintained shall carry clear and durable markings giving the following information:

- secondary (rechargeable) Li or Li-ion;
- polarity;
- date of manufacture (which may be in code);
- name or identification of manufacturer;
- module name;
- rated capacity;
- nominal voltage; and
- appropriate caution statement.

**3.3.4.5** Individual cells shall have a label indicating the number of the cell. These numbers shall run consecutively, commencing with the most positive cell as number one.

**3.3.4.6** 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.

**3.3.4.7** The labels shall be legible from a distance of two metres, (minimum size of 25 mm), and shall have black numbers on a white background, or white numbers on a black background.

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

**3.3.4.9** When specified in Schedule A, individual cells shall be uniquely labelled with a barcode and/or Eskom logo, of which the detail requirements shall be supplied by Eskom. This is required to assist Eskom with battery theft mitigation.

## **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 : 45 °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 : 40 °C
- 2) daily average : 25 °C
- 3) yearly average : 20 °C
- 4) minimum : -5 °C

**3.4.2 Application**

**3.4.2.1** Standby 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 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 (RTUs), telecommunications equipment, control and instrumentation, distributed control systems, and emergency lights.

The substation standing drain is relatively low, with the required standby times dependant on the application and configuration used. The required standby times are in accordance with 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.

**3.4.2.2** The cell manufacturer shall specify the cell operating region. The battery manufacturer shall design the battery system to comply with the cell operating region. The voltage control function of the battery system design shall ensure that the voltage of each cell or cell block shall not exceed the upper limit of the charging voltage specified by the manufacturer of the cells,

In designs where the maximum required battery charging voltage is higher than the maximum input voltage limit of the operating equipment, the load voltage can be 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 and battery management system**

**3.4.3.1** The requirements of IEC 62619:2017, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications, shall apply.

**3.4.3.2** The manufacturer shall indicate the charging regimes to ensure that the battery is safely and optimally charged. Important facts regarding the charging/use of LFP batteries to be noted:

- 1) LFP cell voltage may not drop to below 2,5 V.
- 2) LFP cell voltage may not rise above 4,2 V.

**Note** - The cells of a LFP battery do not auto-balance at the end of the charge cycle.

**ESKOM COPYRIGHT PROTECTED**

**3.4.3.3** The BMS refers to the management and monitoring of the individual cells within the battery assembly and shall be integrated as part of the battery assembly. The BMS is responsible for the safe operation of the battery assembly through the following functions:

- 1) Prevent cell under voltage by timely disconnection of the load.
- 2) Prevent cell over voltage by reducing charge current or stopping the charge process.
- 3) Shut down the system in case of over temperature.
- 4) Break connection to charger and load in case of short circuit (internal and/or external).
- 5) In addition to these safety features, it will also ensure cell balancing is maintained.

**3.4.3.4 State of health (SoH) local and remote alarms indication shall be provided.**

### **3.4.4 Venting of gases**

The requirements of IEC 62619:2017, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications, shall apply.

If charged after the LFP battery was discharged below the discharge cut-off voltage, or when the Li-ion battery is damaged or overcharged, the LFP battery can release a harmful mixture of gases, such as phosphate.

The casing of a cell, module, battery pack, and battery system shall incorporate a pressure relief function that will preclude rupture or explosion. If encapsulation is used to support cells within an outer case, the type of encapsulation and the method of encapsulation shall neither cause the battery system to overheat during normal operation nor inhibit pressure relief.

### **3.4.5 Commissioning**

**3.4.5.1** All LFP cells to be given a commissioning charge that is fully documented in accordance with OEM instructions just before or after installation at site. Special attention is to be given to ensure that all cells are balanced and at 100% charged state.

**3.4.5.2** The successful tenderer shall provide full commissioning instruction documentation in accordance with Eskom standards format.

### **3.4.6 Maintenance**

**3.4.6.1** The tenderer shall include OEM maintenance instructions as part of the tender documentation.

**3.4.6.2** The successful tenderer shall provide full maintenance documentation in accordance with Eskom standards format.

### **3.4.7 Accessories**

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

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

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

### **3.4.8 Inter-row connectors**

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

### **3.4.9 Safety signs**

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

### **3.4.10 Equipment performance**

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

**3.4.10.1** Number of years that offered equipment has been in service;

**3.4.10.2** Customers, indicating units employed, and their contact information;

**3.4.10.3** Environmental conditions where such equipment is installed; and

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

### **3.4.11 Type test certificates, drawings and instruction manuals**

The requirements of IEC 62619:2017, Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for secondary lithium cells and batteries, for use in industrial applications and IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes — Secondary lithium cells and batteries for use in industrial applications, shall apply.

When called for in Schedule A, a full set of independent type test certificates with type test results, reports and certificates for the entire offered range of cells shall be submitted with tender documentation. Any design changes in cells, modules, battery packs or BMS will require a new type test certification process.

**3.4.11.1** The manufacturer shall include a table with the following parameters for the cells, modules or battery packs:

- 1) Cell type;
- 2) C<sub>5</sub> rated capacity [Ah];
- 3) Wet weight mass [kg]; and
- 4) Cell dimensions (length, width, height) [mm].

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

- 1) A technical manual, which covers installation, commissioning, maintenance and safety instructions; and
- 2) Commissioning test results.

### **3.4.12 Tools**

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

### **3.4.13 Spares**

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

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

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

**3.4.13.4** Spares shall be carried at the supplier's local works for the duration of the contract. The spares shall consist of 10% of the installed equipment.

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

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

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

#### **3.4.14 Training**

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

#### **3.4.15 Warranty requirements**

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

**3.4.15.2** A second prorated OEM warranty of at least an additional three 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.

**3.4.15.3** The warranty offered shall be a warranty endorsed by the OEM.

**3.4.15.4** The warranty offered by the OEM shall be in accordance with the environmental conditions as stipulated in this specification.

#### **3.4.16 Local support**

**3.4.16.1** During the commissioning of a bank of cells, the manufacturer or agent shall provide a 24 hour 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 two weeks; and
- 3) The replacement of faulty cells, modules or battery packs.

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

#### **3.4.17 Disposal**

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

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

**3.4.17.3** Processes shall be in place to ensure the following:

- 1) Collection of redundant cells from the Eskom sites.
- 2) Full preparation of the cells, that is, crating of cells or wrapping of cells on pallets for transport.

**ESKOM COPYRIGHT PROTECTED**

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

### **3.4.18 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**

The manufacturer shall indicate as to any specialised maintenance equipment required.

### **3.5.2 Battery cabinets**

The manufacturers to supplied full detailed information on battery cabinets supplied or suitable for installation of LFP cells, modules or battery packs.

#### **3.5.2.1 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 that have been certified by the national calibration service.

**3.6.1.2** Eskom shall decide to witness tests on the batteries at its discretion.

**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 prove compliance with the required specifications in cases where the equipment complies with a similar specification.

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

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 to be available in electronic format.

### **3.6.2 Electrical and mechanical tests**

The requirements of IEC 62619:2017, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications and IEC 62620:2014, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications, shall apply.

### **3.6.3 Test certificates**

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



### **3.6.4 Clearance for dispatch**

The supplier shall obtain agreement from Eskom's Quality Assurance Department before dispatching 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 suborders (on the order documentation), the packaging of this order shall enable the separate suborders 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, conditions 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, 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 of 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 offloading 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 offloading and storage, either in an equipment room building or in a weatherproof location provided by Eskom, shall be the supplier's responsibility. Relevant parties shall be contacted beforehand to ensure that authorised Eskom personnel are available to take possession of the delivery.



## **4. Authorisation**

This document has been seen and accepted by:

<b>Name and surname</b>	<b>Designation</b>
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 and Auxiliary Supplies SC Chairperson
Thomas Jacobs	Chief Engineer DC & Auxiliary supplies
Deon van Rooi	Metering, DC and Security Technologies Manager

## **5. Revisions**

<b>Date</b>	<b>Rev</b>	<b>Compiler</b>	<b>Remarks</b>
Oct 2020	1	C van Zyl	New document

## **6. Development team**

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

- C van Zyl

## **7. Acknowledgements**

Not applicable.

**Annex A – Technical Schedules A and B**

Stationary LFP batteries

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	
	Cells condition on delivery	As specified	
	Commissioning and testing	As specified	
	Accessories	As specified	
	BMS	Yes	
	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	Yes	
3.2	Electrical performance requirements		
3.2.2	Rated capacity	Specify	
3.2.3	Discharge performance at +25 °C	Comply	
3.2.4	Discharge performance at low temperature	Specify	
3.2.5	High rate discharge permissible current	Comply	
3.2.6	Suitability for floating operation	As specified	
	Fully charge state – under float: Voltage/cell [V]	Specify	
3.2.7	Endurance		
	Expected life	15 years	
	End-of-life capacity	80% C <sub>5</sub>	
	Deterioration rate / capacity loss [%Ah/yr]	Specify	
	Number of cycles to 80% C <sub>5</sub>	Specify	
3.2.8	Charge retention		
	28 day storage capacity min 85% C <sub>5</sub>	Comply	
	Charge recovery value min 90% C <sub>5</sub>	Comply	
3.2.9	Short-circuit current and internal resistance		

**ESKOM COPYRIGHT PROTECTED**

Item	Description	Schedule A	Schedule B
	Short-circuit current ( $I_{sc}$ ) [kA] Internal resistance ( $R_{dc}$ ) [ $\Omega$ ]	Specify Specify	
3.2.10	Tolerance to AC components of the DC supply		
	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	
3.2.11	Effect of temperature		
	Effect of temperature on expected battery life Temperature derating – Table/Graph	Specify Specify	
3.3	Mechanical requirements		
3.3.1	General	Comply	
	Performance type E Mechanical stress during transportation/handling Resistance to earthquakes	Low Comply No	
3.3.2	Battery cabinet	Specify	
3.3.3	Terminal posts		
	Recommended torque levels [Nm]	Specify	
3.3.4	Terminal seals	As specified	
3.3.5	Containers		
	Cell construction Cell orientation Flame retardant materials	Specify Specify Comply	
3.3.6	Cell, module and battery pack marking and labelling	As specified	
3.4	Operational requirements		
3.4.1	Environmental conditions		
3.4.1.1	Altitude Relative humidity  Lightning	2200m 10% - 85% non-condensing High	
3.4.1.2	Outdoor air temperatures: Maximum Daily average Yearly average Minimum	45 °C 30 °C 20 °C -10 °C	

Item	Description	Schedule A	Schedule B
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	40 °C 25 °C 20 °C -5 °C	
3.4.2	Application	As specified	
3.4.3	Charging regimes and BMS		
3.4.3.2	LFP cell voltage limits LFP cells min voltage LFP cells max voltage	2,5 V 4,2 V	
3.4.3.3	BMS functionalities Under voltage disconnect Over voltage protection Over temperature shutdown short-circuit protection cell balancing	Comply Comply Comply Comply Comply	
3.4.3.4	Local and remote alarms	Comply	
3.4.4	Venting of gases	As specified	
3.4.5	Commissioning		
	OEM commissioning instructions documentation	Comply	
3.4.6	Maintenance		
	OEM maintenance instructions documentation	Comply	
3.4.7	Accessories: Bolts, nuts, washers and connectors	Yes – As specified	
3.4.8	Inter-row connectors required	Yes – As specified	
3.4.9	Safety signs required	Yes – As specified	
3.4.10	Equipment performance	Specify	
3.4.11	Type test certificates, drawings and instruction manuals	Supply – As specified	
3.4.12	Tools	Specify	
3.4.13	Spares	Specify	
3.4.14	Training	Specify	
3.4.15	Warranty requirements	Specify	

<b>Item</b>	<b>Description</b>	<b>Schedule A</b>	<b>Schedule B</b>
3.4.16	Local support	Specify	
3.4.17	Disposal	As specified	
3.4.18	Equipment limitations	Specify	
3.5	Ancillary equipment		
3.5.1.	Maintenance equipment: Specialised maintenance equipment required	Specify	
3.5.2	Battery cabinets	Yes – Specify	
3.6	Tests		
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		
3.7.1	Packaging	As specified	
3.7.2	Labelling	As specified	
3.7.3	Transport	As specified	

---

**Annex B – Deviation schedule for stationary lithium iron phosphate (LFP) 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