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TITLE: STANDARD FOR ENERGY STORAGE SYSTEMS	**REFERENCE** CP_TSSTAN_150 **REV** 0 **DATE:** APRIL 2021 **PAGE:** 1 **OF** 17

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FOREWORD

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INTRODUCTION

Energy storage system (ESS) can be broadly defined as a system or technology that enables energy produced during a certain period to be used at a different period. Energy storage offers a range of opportunities/applications for standalone developers, consumers, generators as well as network operators, and therefore an opportunity for City Power.

1. SCOPE

This specification covers BESS requirements for grid-connected and off-grid storage applications suitable for City Power.

The supplier/contractor shall be fully responsible for selecting suitable energy storage systems for the City Power grid and its satisfactory performance in service.

2. NORMATIVE REFERENCES

The following document contain provisions that, through reference in the text, constitute requirements of this standard. At the time of publication, the editions indicated were valid. All standards and specification are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

IEC 60050 (all parts), International Electrotechnical Vocabulary (available from:

http://www.electropedia.org)

IEC 62933-1 Ed. 1: Electrical energy storage (EES) systems – Part 1: Vocabulary

SANS 10228:2012-The identification and classification of dangerous goods for transport by road and rail modes

SANS 60623, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells

SANS 60730-1, Automatic electrical controls – Part 1: General requirements

IEC 60812, Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)

IEC 61025, Fault tree analysis (FTA)

SANS 61427-1, Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1: Photovoltaic off-grid application

SANS 61508 (all parts), Functional safety of electrical/electronic/programmable electronic safety-related systems

SANS 62133, Secondary cells and batteries containing alkaline or other non-acid electrolytes –

Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications

ANS 62485-1, Safety requirements for secondary batteries and battery installations – Part 1: General safety information

SANS 62485-2, Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries

SANS 61439, Low-voltage switchgear and control-gear assemblies

SANS 61641, Enclosed low-voltage switchgear and controlgear assemblies - Guide for testing under conditions of arcing due to internal fault

SANS 62040-1, Uninterruptible power systems (UPS) Part 1: General and safety requirements for UPS

SANS 62040-1-2, Uninterruptible power systems (UPS) Part 1-2: General and safety requirements for UPS used in restricted access locations

IEC 62933-2-1 Ed. 1: Electrical energy storage (EES) systems – Part 2-1: Unit Parameters and Testing Methods – General specification

IEC 62619, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for large format secondary lithium cells and batteries for use in industrial applications1

IEC 62620, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications

IEC 62897, Stationary Energy Storage Systems with Lithium Batteries – Safety Requirements

SANS 62109-2, Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters

CP_TSSPEC_017, Specification for Miniature Circuit Breakers

CP_TSSPEC_018, Specification for Moulded Case Circuit Breakers

CP_TSSPEC_214, Specification for Protection Relays

3. DEFINITIONS AND ABBREVIATIONS

The definitions and abbreviations in the above documents shall apply to this specification.

4. REQUIREMENTS

4.1. General

4.1.1. The energy storage system shall be of Lithium-Ion or Vanadium Flow battery technologies and shall be suitable for grid and off-grid applications requirements in table 1.
4.1.2. The battery system shall have life expectancy of 15-20 years rating under normal operating conditions, suitable for outdoor installation, and a battery management system (BMS).
4.1.3. The system shall be modular and scalable.
4.1.4. The batteries shall be supplied in robust containers.
4.1.5. Battery string connectors shall be insulated and configured for single and multiple unit installations.
4.1.6. Balancing of a string/module shall be done online without affecting the operation and required availability of the system.
4.1.7. Any faulty string/module shall be flagged and isolated without affecting the operation and required availability of the system.
4.1.8. It shall be possible to introduce improved battery technologies / models in future, whether for augmentation or upgrading purposes, without changing the connection of the existing battery modules. The Service provider/contractor shall state how this "future-proofing" shall be accommodated in existing designs in terms of the Energy Management System (EMS), Battery Management System (BMS) and Power Conversion System (PCS).

4.2. Environmental Conditions

The system shall be suitable to be operated under the following conditions:

4.2.1. At an altitude above sea level up to 1800m
4.2.2. At ambient air temperatures; maximum 40 ºC and minimum −10 ºC
4.2.3. Relative humidity of not more than 90 %

Table 1: Battery Storage Grid Applications requirements

Application	Description	Response Time	Typical discharge time	Typical size	Charge / Discharge behavior
Peak shaving	Peak shaving to reduce NMD	Minutes	2 – 4 hours	100 kW – 10 MW	50 – 500 cycles per year
Energy Arbitrage	Generating energy at low-cost periods, storing, and selling at peak periods.	Minutes	1 – 6 hours	1 kW – 1 MW	50 – 250 cycles per year
Load levelling / peak shaving for grid upgrade deferral	Reducing limited-time peak loads to assist in maintaining thermal load and voltage within planning limits, thereby deferring network upgrade.	Minutes	1 – 8 hours	1 – 100 MW	10 – 365 cycles per year
Electrification (hybrid PV and storage)	Off-grid systems. Inverter must be capable of grid forming.	Minutes	4 – 12 hours	10 kW – 1 MW	365 cycles per year (charges during middle of day, discharges morning and evening)
Reliability	Micro grid / islanded operation during planned or unplanned system outages. Inverter must be capable of grid forming.	Minutes	1 – 12 hours	1 – 10 MW	< 10 cycles per year
Frequency regulation	Automatic absorption or supply of power during a frequency deviation event	Milliseconds	2 minutes – 1 hour	1 MW – 1 GW	1 000 – 10 000 cycles per year
Renewables smoothing	For small fluctuations in intermittent renewable energy generation.	Seconds	30 minutes – 6 hours	1 – 100 MW	250 – 10 000 cycles per year
Load following	Used to supply or absorb power to compensate for system load variations around the forecast level.	Milliseconds – 1 s	15 minutes – 1 hour	MW – 100 MW	250 – 10 000 cycles per year

The contractor shall include a description of the intended energy storage application/s as requested by City Power. This shall include details and sizing calculations (and or simulations) of how the proposed BESS will meet the anticipated operation scheme for each application. The BESS capacity apportionment to provide the different stacked benefits shall be tabulated and additional benefits shall be stated. Calculation factors to account for operating temperature, expected growth, various discharge rates under various control modes; capacity degradation etc. shall be stated.

4.3. Battery management system (BMS)

4.3.1. The BMS shall be designed to ensure automatic, unattended operation of the BESS.
4.3.2. The BMS shall provide the necessary monitoring and control to protect the battery cells/module/string from out of tolerance or unsafe operating conditions.
4.3.3. The BMS shall automatically control the safe charge and discharge of the individual cells/modules/strings.
4.3.4. The BMS shall automatically control balancing between cells/modules/strings (where applicable) to ensure optimised state-of-charge, state-of-health and life expectancy.
4.3.5. The BMS shall automatically monitor cell/module/string heath and provide critical safeguards to protect the batteries from damage.
4.3.6. The BMS shall monitor and report in real time (via SCADA) on the following parameters for each lowest maintainable unit / module:

a) State-of-Charge (SoC)
b) State-of-Energy (SoE)
c) State-of-Health (SoH)
d) Battery temperature
e) Charge current
f) Discharge current
g) DC bus voltage
h) Cell / Module / Stack voltages (Minimum and maximum)
i) Cell / Module / Stack / Electrolyte temperatures (Minimum and maximum)

4.3.7. The BMS shall monitor and report in real time (via SCADA) on the following alarm or warning conditions for each lowest maintainable unit / module:

a) Over-temperature
b) Overcharge
c) Over-discharge
d) Undercharge

4.4. Power conversion system (PCS)/BESS Inverter

4.4.1. General

4.4.1.1. The Power Conversion System (PCS) is the interface between the DC battery system and the AC system and provides for charging and discharging of the battery. It may consist of one or more parallel units.
4.4.1.2. The PCS shall function as both an AC→DC power factor controlled rectifier and a DC→AC inverter and can smoothly transition between these operations while in the online state. While acting as a rectifier, it can provide DC power while drawing clean sinusoidal input current with low harmonic distortion from the power grid. While acting as an inverter, it draws DC power and delivers clean sinusoidal current to the power grid.
4.4.1.3. The PCS shall consist of solid state electronic switches (IGBTs) along with associated control & protection, filtering, measuring instruments and data logging devices.
4.4.1.4. The PCS shall be bi-directional inverter that can provide real and reactive AC power simultaneously with full four quadrant operation.
4.4.1.5. The PCS shall comply with SANS 62109-2.
4.4.1.6. All LV switchgear and control gear shall comply with the requirements of SANS 61439/CP_TSSPEC_017/ CP_TSSPEC_018.
4.4.1.7. The ability of the assembly of LV switchgear to limit the risk of personal injury, damage of assemblies and its suitability for further service as a result of an internal arcing fault shall be in accordance with SANS 61641.

4.4.2. System Operation

4.4.2.1. The PCS shall be modular and scalable. Hot-plug ability is preferred, but not mandatory. The modules may be rack-mounted facilitating easy and safe handling.
4.4.2.2. Multiple PCS shall be capable of operating in parallel, assuming isolation is provided on the AC bus, while maintaining adequate load sharing with failure proof controls.
4.4.2.3. The PCS shall operate on the always-on principle where power output is derated based on operating temperature limitations.

4.4.3. Monitoring and Controls

4.4.3.1. The PCS shall be capable to adjust the output voltage & frequency to suit the grid condition. The PCS shall be able to synchronize with the grid frequency and provide a stable output – appearing to the grid to be a synchronous generator.
4.4.3.2. Suitably rated contactors or equivalent automated disconnecting devices shall be provided for the connection of the inverter input – and output terminals to the battery DC bus and to the three phase AC isolation power transformer, respectively.
4.4.3.3. A disconnect switch, with padlock capability, shall be provided for isolation of the inverter from the DC battery string.
4.4.3.4. A lockable AC disconnect shall be provided for the connection of the PCS to the isolation power transformer.
4.4.3.5. An option for disconnects with visible contacts may be provided upon customer request.
4.4.3.6. Suitably rated overcurrent protection devices shall be provided on both the AC and DC buses.
4.4.3.7. Communication ports shall be provided for interaction with the BMS and EMS, where applicable.
4.4.3.8. Local connection via a computer shall be possible for maintenance purposes.
4.4.3.9. All fault conditions and events shall be date-and-time stamped and shall be retained in memory in the event of power loss for later recall.
4.4.3.10. The operator interface shall consist of an emergency stop button, a means to enable and disable the system and status indicators.
4.4.3.11. The operator interface shall be capable of controlling the PCS, displaying system status, and annunciating any fault conditions.
4.4.3.12. Where the PCS is not part of the battery system container / cabinet, it shall be installed in an outdoor rated cabinet.
4.4.3.13. The following PCS parameters shall be monitored and reported on in real time for each lowest and High maintainable unit / module:
a) DC current
b) DC bus voltage
c) DC power
d) AC phase currents
e) AC phase voltages
f) Power factor
g) AC real power
h) AC reactive power
i) AC apparent power
4.4.3.14. The Service Provider/Contractor shall specify a list of all critical PCS parameters that can be monitored via the EMS.

4.5. Balance of System

4.5.1. The Service Provider/Contractor shall list all equipment / sub-systems that make up the balance of plant and indicate how it interfaces with the EMS.
4.5.2. All LV switchgear and control gear shall comply with the requirements of SANS 61439/ CP_TSSPEC_017/ CP_TSSPEC_018

4.6. BESS Management and Control

4.6.1. General

Safety management functions and operational management functions shall be embedded at different levels of the BESS.

4.6.2. Energy management system (EMS)

4.6.2.1. The BESS management system (also referred to as the Energy Management System) shall facilitate the real time monitoring, operation, control, reliable, efficient and safe operation and performance optimization of the BESS system.

4.6.2.2. The EMS shall be able to acquire real time data, status – and alarm information from all critical subsystems necessary for the effective and safe operation of the BESS:

a) Switchgear (HV/MV or LV)
b) Transformers (MV or LV)
c) Protection relays and schemes (CP_TSSPEC_214)
d) Energy and power meters
e) UPS
f) Power Conversion System
g) Fire System
h) GPS Time Synchronisation unit
i) Battery Management System
j) HVAC system
k) Any other equipment deemed necessary

4.6.3. The EMS shall display the following system parameters:

a) Grid Voltages
b) Grid Currents
c) Power factor
d) Apparent Power
e) Reactive Power
f) Active Power
g) System status and alarms
h) System temperature
i) Ambient temperature
j) All other data necessary for operation and fault finding, including diagnostics and self-check functions

4.6.3.1. It shall be possible to configure operational settings (e.g. set points, etc.) of all subsystems from the EMS.

4.6.3.2. The ramp rate of charging and discharging of the BESS shall be programmable or set to a defined value by manually entering a value into the BESS HMI or by the SCADA system communicating a ramp rate set point.

4.6.3.3. All modes of operation and its operational set-point functionality shall be remotely adjustable to allow change in settings and to turn on/off all controls or modes when appropriate.

4.6.3.4. The EMS shall log and store critical system parameters, alarms, events and trends required for the effective performance management of the BESS. This data shall be date and time stamped.

4.6.3.5. It shall be possible to configure the EMS with user-friendly configuration files.

4.6.3.6. It shall be possible to generate, store and retrieve user configurable periodic reports. It shall be possible to generate these reports in MS Office (MS Word or MS Excel) formats.

4.6.3.7. The EMS of each BESS installation shall be capable of operating on autonomous control as well as control from a Central SCADA that manages a fleet of installations.

4.6.3.8. The EMS shall ensure safe BESS operation under all operating conditions, inclusive of any plant disturbances and component failures.

4.6.3.9. The BESS shall remain functional in the absence or loss of communication from the remote controller. The BESS shall continue its current mode of operation for a set time period (variable setting, 15 minutes default). On expiration of the time, the BESS shall standby.

4.6.3.10. During an interruption to communications, the remote controller will make repeated attempts to re-establish communications at a set time interval (variable setting, default of 5 minutes). When communications have been re-established, the BESS and remote controller shall make any necessary updates to resume performance.

4.6.3.11. The EMS design shall incorporate redundancy to ensure the continued operation of the BESS in the event of the failure of a main processing unit. The vendor shall indicate in the Tender how redundancy is achieved and how will this impact on the HMI and SCADA functionality of the EMS.

4.6.3.12. There shall not be redundant communication between the SCADA control centres and the EMS which shall be taken into account in the redundancy design of the EMS (e.g. switch over of SCADA communications between the main EMS and standby EMS).
4.6.3.13. Manual (local and remote) intervention shall always be possible at any stage of operation in compliance with the following priority assignment: Protective commands shall have priority over manual command and manual commands shall prevail over automatic commands.
4.6.3.14. The control algorithms shall be designed to fulfil primary use cases and optimise stacked benefits.
4.6.3.15. The EMS shall be capable of computing and displaying business case benefit in the form of cumulative revenue earned and operating costs incurred, for the life of the asset. Revenue shall be based on contracted earning formulas and costs shall be based on energy costs and operating and maintenance costs. These figures shall be included in the reporting and analytics capability of the installation.
4.6.3.16. The EMS shall be capable of keeping track of how the BESS perform compared to warranty requirements and report on exceptions.
4.6.3.17. Taking into account the manufacturer's expected lifespan of the installed battery technology, the time and date at which the unit was commissioned, the number of charge and discharge cycles, the depth of discharge etc. the EMS shall be able to indicate the estimated remaining lifespan of a battery cell, rack and/or string.
4.6.3.18. The EMS shall also indicate based on the estimated lifespan what the maximum charge/discharge capability of each battery cell, rack and/or string is as a percentage (with 100% representing the designed charge/discharge capacity of the battery when new).

4.6.4. Human Machine Interface (HMI)

4.6.4.1. The BESS system shall provide a local HMI in the BESS control room which will provide a facility to locally control the system while providing a view of the plant statuses and alarm conditions at the station.
4.6.4.2. The HMI shall provide a graphical interface for monitoring and control of the substation. The HMI shall allow the battery and electrical system to be drawn with the appropriate status points and alarms being indicated. It shall be IEC approved electrical components/symbols be used/supported on the HMI drawing tool (e.g. bi-directional converter symbol, energy storage device symbol).
4.6.4.3. It is preferred that the ability to access settings and configure BESS subsystem components is possible via the HMI.
4.6.4.4. The HMI system shall be rated for 24/7 continuous use.
4.6.4.5. All interactions (viewing and control) of the HMI shall be done via a display (non-touch/touch).
4.6.4.6. The HMI hardware and display shall be suitably rated for operation in the harsh environments in which it will be installed in.
4.6.4.7. The life expectancy of the HMI hardware shall be greater than 10 years.
4.6.4.8. Fanless, redundant solid state drives shall be provided.
4.6.4.9. The HMI shall be remotely accessible from the City Power Network.
4.6.4.10. It is recommended that the HMI support a web-based view that can be served to external web-browsers. If supported, such functionality shall use HTML5.
4.6.4.11. A safety requirement of this system is that the HMI from which the City Power/third party operator can monitor and control the BESS system shall be located in an environment that is free of equipment that can cause any harm to the operator during their operating processes (e.g. switches, inverters, battery banks).
4.6.4.12. It is recommended that all incorrect operations shall be indicated to the operator by suitable text messages on the HMI screen.
4.6.4.13. All control functions relating to output data (i.e. control of primary plant) shall include a confirmation window to ensure accidental operations are avoided.
4.6.4.14. All control actions initiated via the local HMI shall be subject appropriately interlocked to ensure safety to person and plant at all times.
4.6.4.15. The HMI shall support the viewing of this Sequence of Event data captured by via a Gateway.

4.6.5. GPS Time Synchronisation Device

The BESS shall include a Global Positioning System (GPS) Time Synchronisation unit (master clock) suitable for use in substation/industrial environments for the purposes of time synchronising all the devices and events within the BESS.

4.6.6. Power Supplies Requirements

4.6.6.1. There shall be no equipment malfunction, damage or spurious event, under any of the following conditions:

a) As a result of the loss or restoration of supply.
b) As a result of an under-voltage (-20%) or over-voltage (20%) condition of the nominal voltage supply.
c) If either AC or DC supplies to the unit are switched off and on repeatedly at a random rate.
d) Short interruptions on any of the power supply voltages for not longer than 20ms occurring in a random sequence for a period of no longer than 20s.

4.6.6.2. All critical sub-systems shall be powered from an UPS in order to remain operational in the event of an auxiliary power supply failure. This is necessary to ensure the safe shutdown of the BESS and also to enable continued remote monitoring and control from the Network Management Centre.

4.6.6.3. The UPS shall comply with the requirements of IEC 62040-1 and IEC 62040-1-2.

4.6.6.4. The power supplies shall have the necessary over-temperature protection, current overload cut-outs and over-voltage limiting, with automatic reset on removal of the fault.

4.6.6.5. If the EMS Gateway is supplied from a DC source, the noise measured across the power supply terminals of the equipment under test shall not be greater than 2 mV peak-to-peak or -58dBV (0dBV = 0,775V).

4.6.6.6. The power supply unit shall provide galvanic isolation between the primary supplies and the electronic circuitry.

4.6.6.7. The output terminals for powering the external DCE/converters shall be capable of accepting 2,5mm^2 cable.

4.6.7. System Operation

4.6.7.1. When the auxiliary power supply to the control system fails and cannot be maintained by any other means, the control system shall shutdown the BESS in a safe manner.

4.6.7.2. The BESS control system shall be designed to provide for automatic, unattended operation of the BESS. However, the control system design also shall provide for local manual operation, remote operation, or dispatch of the BESS from City Power’s SCADA system or remote access point.

4.7. EMS/BESS SCADA gateway

4.7.1. Consideration shall be given to ‘tried and tested off-the-shelf’ solutions/equipment and firmware.

4.7.2. The Gateway hardware shall be suitably rated for operation in the harsh environments.

4.7.3. The life expectancy shall be greater than 10 years.

4.7.4. The BESS SCADA Gateway shall comply with the requirements specified in Grid connection code for Renewable Power Plants connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa.

4.8. Safety Requirements

4.8.1. The service provider/contractor shall identify and classify any dangerous substance/s in the BESS as per SANS 10228. Any claims of no hazardous / dangerous substances shall be supported with applicable certification or expert, 3rd party assessment reports.

4.8.2. The ability of the assembly to limit the risk of personal injury, damage of assemblies and its suitability for further service as a result of an internal arcing fault shall be in accordance with SANS 61641.

5. LABELLING

The system description shall cover the following information:

5.1. BESS type / classification (either Lithium-Ion or Flow battery).
5.2. BESS Chemistry.
5.3. Identify and classify any dangerous substance/s in the BESS as per SANS 10228. Any claims of no hazardous / dangerous substances shall be supported with applicable certification or expert, 3rd party assessment reports.
5.4. Battery Nameplate Energy rating [kWh] – from smallest cell, module, string, container to full system.
5.5. Battery Nameplate Power rating [kW] – from smallest cell, module, string, container to full system.
5.6. Number of battery cells, modules, strings and how they are aggregated to the complete systems.
5.7. Information on the internal cells or stack are to be provided including specifics of the technology, cell format, electrolyte, electrical rating of the cell or stack, and how many are contained within a full battery.
5.8. Internal resistance (i.e. the resistance to power flow of the ESS during charge and discharge)
5.9. Tank configuration and sizes (for flow batteries). Labelling sub-section
5.10. A complete description (inclusive of their functions) of the balance of plant components such as cooling systems, controls including BMS, pumps, etc.
5.11. Complete footprint [m^2] – i.e. physical dimensions with all components in place. Labelling sub-section
5.12. System placement configuration e.g. stacked or side-by-side or back-to-back, etc.
5.13. Battery manufacturer, model or part number. Labelling sub-section
5.14. Date of manufacture.
5.15. PCS manufacturer, model or part number, nameplate power rating [kW], modularity and number of PCSs, hardware and software versions. Labelling sub-section
5.16. BMS supplier, model or part number, hardware and software versions. Labelling sub-section
5.17. EMS supplier, model or part number, hardware and software versions
5.18. Photos, diagrams, drawings and schematics should be provided to give a complete description of the full system.

6. TESTS

6.1. General

6.1.1. The supplier shall cover the cost of all testing required and is requested to provide City Power with the details of when and where these tests will be conducted.
6.1.2. All type testing shall be done at accredited local test facilities or accredited international testing authorities/facilities, unless otherwise permitted for specific BESS.
6.1.3. Only type tested and service proven BESS designs (all components) shall be tendered and accepted for use by City Power.
6.1.4. Service provider/contractor shall submit all the required type test reports. Certification and type test reports shall be applicable to the system/solution being proposed.
6.1.5. If the units offered have been tested for compliance with an internationally accepted standard, City Power may accept those test reports in place of the tests covered by this specification. These type test reports and alternative test standards shall be submitted with the service provider/contractor, for City Power's consideration. However, the Service provider/contractor shall state clearly the difference between the requested standard and the offered standard by way of a tabulated comparison. This shall also be noted on the deviation schedule.
6.1.6. The FAT, SAT and routine tests procedures shall be agreed to between City Power and the manufacturer or supplier of the equipment.
6.1.7. The service provider/contractor shall provide FAT, SAT and routine/periodic tests procedures and schedules for previous BESS projects that have been executed.

6.2. Type Test

6.2.1. BESS component type test certificates and type test reports shall be provided in the tender submission.
6.2.2. Type test reports and certification of the entire energy storage system, whereby the individual components are integrated into the system providing overall system functionality shall be provided in the tender submission.

6.3. Factory acceptance test

The factory acceptance tests (FAT) are tests conducted at the manufacturers premises prior to equipment release and dispatch to the customer. The tests are conducted on each BESS unit/components to verify the manufacturer's declared equipment performance criteria and rectify any defects arising on the equipment prior to dispatch to the customer.

6.3.1. As a minimum, factory acceptance test certificates shall be provided for the following components:
   a. Battery modules;
   b. Power Converters;
   c. Transformers
   d. Control and Management systems.
6.3.2. The manufacturer or supplier shall perform a pre-FAT according to the accepted Factory Acceptance Test (FAT) Procedure.
6.3.3. The pre-FAT and, FAT procedures shall include as a minimum the following:
   a. Proposed FAT
   b. Testing methodology and set up process
   c. Tests to be performed
   d. Test acceptance criteria.
6.3.4. The FAT shall only commence once City Power has approved this pre-FAT report and results. The manufacturer or supplier and City Power shall agree upon a date when formal FAT shall commence. The testing shall then be carried out in accordance with the FAT procedure.
6.3.5. In the event of any tests malfunctioning, City Power may elect to restart the complete test procedure from the beginning.
6.3.6. City Power may elect to conduct an unstructured testing programme (Free-form Tests), at its discretion, on the manufacturer or suppliers premises for a duration of two weeks. This two-week period shall not include the time taken to repair any faults.
6.3.7. The manufacturer or supplier, at no extra charge to City Power, shall correct any errors detected.
6.3.8. Once City Power has satisfied itself that the system has passed the prescribed tests, the BESS unit(s) shall officially be released for factory dispatch.

6.4. Site acceptance test

6.4.1. After delivery of the BESS unit to the pre-determined City Power site, the Supplier, assisted by the City Power where agreed, shall install the equipment in a substation in accordance with the applicable standards and OEM manuals.
6.4.2. The SAT procedures shall include as a minimum the following:
   a. Proposed SAT
   b. Testing methodology and set up process
   c. Tests to be performed
   d. Test acceptance criteria.
6.4.3. The manufacturer or supplier shall make available at no extra charge to City Power the relevant hardware, software and/or system specialist.
6.4.4. For a period of one month after the successful completion of the formal SAT, the equipment shall be subjected to a soak test.
6.4.5. In the event of any non-conformance being detected, the manufacturer or supplier shall be required to commence the correction of the errors within a 72 h period. Only on completion of the correction procedure, the one-month test and soak test period shall commence.
6.4.6. In the event that fundamental error(s) are detected and depending on the nature of the fault, City Power may at its sole discretion elect to restart the SAT.

6.5. Functionality and Performance Tests

6.5.1. Performance of the BESS or subsystems shall be conducted by agreed to testing methodologies, thereby verifying that the declared BESS parameters are in accordance with customer applications and technical requirements.

6.5.2. Performance tests of the BESS shall conform to:

a) IEC 62933-2-1: Electrical energy storage (EES) systems – Part 2-1 and

b) IEEE Std 2030.3-2016 Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications, whereby the BESS parameters, system performance and system implementation shall be tested and verified at various life cycle phases in the BESS development.

6.5.3. In compliance to IEEE Std 2030.3-2016 Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications, the BESS system functionality shall be proven at various phases of the BESS development.

6.5.4. The Service Provider/Contractor shall confirm conformance to the minimum following functionality tests in Table 2 and deviations to the testing IEC/IEEE methodology or declared values shall be provided in the deviation schedule.

Table 2: Minimum BESS Test Overview

Item	Test Description	IEC 62933-2-1 Sub-clause	Type Test	FAT	SAT	Routine Tests
1	Environmental Conditions	5.1.2 & 5.1.3	✓			
2	Actual energy test	6.2.1	✓	✓	✓	✓
3	Input and output power rating test	6.2.2	✓	✓	✓	✓
4	Roundtrip efficiency test	6.2.3	✓	✓	✓	✓
5	Expected service life test	6.2.4	✓			✓
6	Dynamic Tests	6.2.5				
6.1	System response test		✓			✓
6.2	Step response time test		✓			✓
6.3	Ramp rate test		✓			✓
7	Auxiliary Power	6.2.6	✓			✓
8	Self-Discharge ESS system test	6.2.6	✓			
9	Rated voltage and frequency test	6.2.8	✓	✓		
10	Visual Inspection	6.4.1	✓		✓	✓
11	Continuity and validity of the Conductors	6.4.2	✓		✓	
12	Earthing test	6.4.3	✓		✓	
13	Insulation test	6.4.4	✓		✓	
14	Protection Device Test	6.4.5	✓	✓	✓	✓
15	Equipment and basic function test	6.4.6	✓		✓	✓
16	Grid connection compatibility test	6.4.7	✓		✓	
17	Voltage Immunity Test	6.4.7.2	✓			
18	Available Energy test	6.4.8	✓			
19	EMC immunity test	6.4.9	✓			
20	Voltage Unbalance (IEEE 2030)		✓			✓
21	Unintentional Islanding (IEEE 2030)		✓			✓

7. QUALITY MANAGEMENT

A quality management system shall be set up in order to assure the quality during manufacture, installation, removal, transportation and disposal of scrap material/Waste/E-waste .Guidance on the requirements for a quality management system may be found in the following standards: ISO 9001:2015. The details shall be subject to agreement between the purchaser and supplier.

8. ENVIRONMENTAL MANAGEMENT

An environmental management plan shall be set up in order to ensure the proper environmental management and compliance is adhered to during manufacture, installation, removal, transportation and disposal of scrap material/Waste/E-waste. Guidance on the requirements for an environmental management system shall be found in ISO 14001:2015 standards. The details shall be subject to agreement between City Power and the Supplier. This is to ensure that the asset created conforms to environmental standards and City Power SHERQ Policy.

9. HEALTH AND SAFETY

A health and safety plan shall be set up in order to ensure proper management and compliance during manufacture, installation, removal, transportation and disposal of scrap material/Waste/E-waste. Guidance on the requirements of a health and safety plan shall be found in OHSAS 18001:2007/ ISO 45001:2018 standards. The details shall be subject to agreement between City Power and the Supplier.

ANNEXURE A - BIBLIOGRAPHY

240-139687256: Battery Energy Storage Systems for Grid-Scale Applications-Eskom

ANNEXURE B: Revision Information

DATE	REV. NO.	NOTES
April 2021	0	First issue.