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Foreword

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2016

1. INTRODUCTION

This specification details requirements for battery chargers to be procured for City Power's substations, for charging the batteries and simultaneously to power the connected direct current (D.C.) system load of the feeder boards during normal and abnormal operating conditions.

2. SCOPE

This specification covers the design, manufacturing, testing, quality assurance, delivery to site, off-loading, installation and commissioning of a battery charger to be ordered for upgrade and new substations. The specification also allows for replacements of lead acid and nickel-cadmium battery chargers that are damaged at existing substations.

3. NORMATIVE REFERENCES

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

Reference	Description
SANS 1652	Battery chargers – Industrial type.
SANS 1091	National Color Standard.
SANS 1632–3	Batteries: Vented-type prismatic nickel-cadmium cells and batteries.
SANS 10103	The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication.
SANS/ISO 14001	Environmental management systems — Requirements with guidance for use
SANS 9001	Quality management systems - Requirements

4. DEFINITIONS AND ABBREVIATIONS

- 4.1 Acceptable: Acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant.
- 4.2 Battery: (see also section 4.17 (electrochemical) cell or battery) two or more cells connected together to provide a specified voltage and a specified ampere-hour capacity.
- 4.3 Battery charger: A device capable of providing charging power to a battery.
- 4.4 Boost charge: A partial charge, generally at a high rate, for a short period. It is also known as a fast charge or a quick charge [IEV 486-04-04].
- 4.5 Cable gland: A device to seal and secure the sheath and to secure the armour, where provided, of an electric cable to the terminal equipment, by means suitable for the type of the cable for which it is designed, including provision for making electrical connection to the sheath and to the armour.

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- 4.6 Capacity: The quantity of electricity or electric charge which a fully charged battery can deliver under specified conditions [IEV 486-03-01].
- 4.7 NOTE: The SI unit for electric charge is the coulomb (1 C = 1 A.s), but in practice, battery capacity is usually expressed in ampere-hours (A.h).
- 4.8 Cell: an assembly of electrodes and electrolyte which constitutes the basic unit of a secondary battery [IEV 486-01-02].
- 4.9 Charge (of a battery): An operation during which a battery receives, from an external circuit, electrical energy which is converted into chemical energy [IEV 486-01-11].
- 4.10 Charge rate: the current at which a battery is charged [IEV 486-03-06].
- 4.11 Connector: A component that terminates conductors for the purpose of providing connection and disconnection to a suitable mating component.
- 4.12 Constant current charge: A charge during which the charging current is maintained at a constant value [IEV 486-04-01].
- 4.13 Constant voltage charge: A charge during which the voltage across the battery terminals is maintained at a constant value [IEV 486-04-02].
- 4.14 Clearance: The shortest distance between two conductive parts, usually measured through air.
- 4.15 Creepage distance: The shortest distance along the surface of the insulating material between two conductive parts [IEV 151-03-37].
- 4.16 Disconnecter: A mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements [IEV 441-14-05].
- 4.17 Efficiency of a battery: The ratio of the output power of a battery to the input power required to restore the initial state of charge under specified conditions of current rate, final voltage and temperature. It can be expressed in two forms:
- 4.18 Charge efficiency: The electrochemical efficiency expressed as the ratio of ampere-hours output to the ampere-hours input required to restore the initial state of charge or
- 4.19 Energy efficiency: the electrochemical efficiency expressed as the ratio of watt-hours output to the watt-hours input required to restore the initial state of charge.
- 4.20 (Electrochemical) cell or battery: An electrochemical device or system capable of storing electrical energy in chemical form from which it can be reconverted into electrical energy.
- 4.21 End-of-charge rate: The current applied during the final stage of charging a battery.
- 4.22 Equalizing charge: An extended charge applied to correct relative density imbalance amongst the cells of a battery.
- 4.23 Filter (DC): A resistance or capacitance or inductance network, or any combination of these, arranged to attenuate the residual AC component after rectification.
- 4.24 Float charge: A constant voltage charge ideally sufficient to maintain a cell or battery in a fully charged state.
- 4.25 Floating operation: The normal operation when the energy required by the external circuit is derived from both the battery and the charging circuit.
- 4.26 Fully charged state (of a cell or battery): A state where all the available active material has been reconverted to its fully charged state [IEV 486-03-37].
- 4.27 Gassing: The formation of gas produced by electrolysis of the electrolyte [IEV 486-03-24].
- 4.28 Hazardous voltage: A peak AC voltage exceeding 42,4 V or a DC voltage exceeding 60 V, that exists in a circuit that does not comply with the requirements for a limited-current circuit.
- 4.29 Initial voltage (of a cell or battery): The on-load voltage of a cell after closing the external circuit, as soon as the transient polarization effects have subsided [IEV 486-03-17].

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- 4.30 Isolation voltage: The maximum AC or DC voltage that may be continuously applied between input and chassis of equipment, or output and chassis of equipment, or both.
- 4.31 Lead-acid battery: A secondary battery in which the electrodes are made mainly from lead and the electrolyte is a sulfuric acid solution [IEV 486-01-04].
- 4.32 Limited-current circuit: A circuit that is so designed and protected that, under both normal conditions and a possible fault condition, the current that can be drawn is not hazardous.
- 4.33 NOTE: For frequencies below 1 kHz, the current drawn through a non-inductive resistor of 2 000 Ω , connected between an accessible part and either pole of a limited-current a.c. circuit, does not exceed 0,7 mA or a d.c. current of 2 mA.
- 4.34 Load: A device that absorbs power [IEV 151-03-08].
- 4.35 Moulded-case circuit-breaker MCCB: A circuit-breaker having a supporting housing of moulded insulating material forming an integral part of the circuit-breaker [IEV 441-14-24].
- 4.36 Nickel-cadmium cell: An alkaline secondary cell in which the positive material is made mainly from nickel and the negative material is made mainly from cadmium with an electrolyte of diluted potassium hydroxide.
- 4.37 Noise: The aperiodic, random component on a power source output which is unrelated to the source and switching frequency. Unless otherwise stated, it is expressed in peak-to-peak units over a specified bandwidth.
- 4.38 Overcurrent protection: Protection of the battery charger against excessive current, including short-circuit current.
- 4.39 Protective devices: Circuit breakers that are capable of detecting and automatically breaking their appropriate AC or DC short circuit fault currents. The circuit breakers shall comply with SANS 60269-1 and SANS 60269-2 or SANS 556-1 or SANS 60947-2.
- 4.40 Rated output current: The maximum current that a battery charger is designed to provide at a specified temperature.
- 4.41 Regulation: The variation of selected parameters expressed as a percentage of nominal value, resulting from changes in influencing quantities.
- 4.42 Relative ripple current: The ratio of the r.m.s. ripple current to the mean value of the direct current, expressed as a percentage.
- 4.43 Remote sensing: A means by which a battery charger maintains the stabilized value of output voltage at an external point (such as the battery or load) rather than at its output terminals.
- 4.44 Ripple current: The AC current component in the output of a rectifier that delivers direct current.
- 4.45 Ripple voltage: The AC voltage component in the output of a rectifier that delivers direct current.
- 4.46 Short-circuit protection: A protective feature that limits the current under short-circuit conditions, to prevent the equipment from being damaged.
- 4.47 Soft start: A feature that limits the start-up switching currents of a switching supply and causes the output voltage to rise gradually.
- 4.48 Stability: The capability of a device to regain a steady state of operation after a disturbance.
- 4.49 Stabilized battery charger: A battery charger that contains means to minimize the deviations in the output quantities which are caused by changes in the influencing quantities.
- 4.50 Two-step charge (Two-rate charge): A charge which starts at a given current and, at a pre-determined point, continues at a lower current [IEV 486-04-07].
- 4.51 Valve regulated sealed (secondary) cell: A secondary cell which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive addition to the electrolyte [IEV 486-01-20].
- 4.52 Vented battery: A secondary cell or battery that has a cover which is provided with an opening through which gaseous products can escape.

- 4.53 Withstand voltage: The maximum voltage that can be applied between separate circuits without causing failure.

5. GENERAL REQUIREMENTS

5.1 Service conditions

- 5.1.1 The requirements in this specification apply to battery chargers for use under the following general conditions:

- 5.1.1.1 Indoors
- 5.1.1.2 Altitude : 1 800 m (above sea level);
- 5.1.1.3 Maximum Ambient air temperatures : + 40 °C
- 5.1.1.4 Minimum Ambient air temperatures : -10 °C;
- 5.1.1.5 Relative humidity : +/- 90 %.
- 5.1.1.6 Area : High lightning area

5.2 Alternating current (AC) input

5.2.1 Input characteristics

- 5.2.1.1 The A.C. input voltage shall be within ± 10 % of 400V which is the nominal voltage as per SANS 1652:2013.
- 5.2.1.2 The A.C. input frequency shall be within ± 5 % of 50Hz which is the nominal frequency.
- 5.2.1.3 The A.C. input system shall be properly earthed as per SANS 1652:2013.

5.2.2 Primary power isolation

- 5.2.2.1 For the purposes of servicing, a disconnecting device or devices shall be provided to isolate the battery charger from the primary supply point. Any parts in the battery charger on the supply side of the disconnect device that would remain energized, shall be so guarded as to prevent accidental contact by personnel in accordance with SANS 1652:2013
- 5.2.2.2 The disconnecting device shall isolate all phases (Single or Three Phase) of supply simultaneously and may be provided with padlock operated locking facilities.
- 5.2.2.3 The disconnecting device as indicated in (5.2.2.2 above) shall be a switch or switch-disconnector that complies with SANS 60947-3 and is of utilization category that is suitable for the particular application.

5.2.3 Input protective device

- 5.2.3.1 The charger shall have short-circuit protection by means of an adequately rated protective devices.
- 5.2.3.2 In the case of a battery charger that is not intended to be permanently connected to fixed wiring (i.e. portable charger), it shall have a built-in protective device as in 5.2.3.1 for protection of its internal wiring in addition to the substation's electrical installation.

5.2.4 Protection against lightning surges

- 5.2.4.1 The battery chargers shall be fitted with surge arresting devices to protect the battery charger against the effects of lightning surges. The devices shall be rated to withstand the voltage and current impulses given in table 1.

1	2	3	4
Impulse		Type of load circuit	Energy absorbed by an arrester with a maximum clamping voltage of 1 000 V
Waveform	Amplitude		
1,2/50 μ s 8/20 μ s	6 kV 3 kA	High impedance Low impedance	- 80 J

Table 1: Standard lightning impulse voltage and lightning impulse current for indoor environment

5.3 Direct current (DC) output

5.3.1 Output characteristics

The float, boost, equalize and initialize charge voltages range per cell at the battery terminals and at an ambient battery temperature of 25°C for Lead Acid cell or 20°C for a Nickel Cadmium cell.

The various voltage magnitudes for the batteries may be as follows:

1	2	3	4	5	6
Battery Type	Nominal Voltage	Float Charge	Boost Charge	Equalize Charge	Initial Charge
Lead Acid Cells	2.0	2.15 – 2.33	2.25 – 2.40	2.50 – 2.70	2.25 – 2.70
Nickel Cadmium Cells	1.2	1.35 – 1.45	1.50 – 1.60	1.70	2.25 – 2.70

NB: City Power shall contact the battery manufacturer for Float, Boost and Equalize voltages appropriate to the type of batteries being used and the service conditions under which the batteries will operate.

5.3.2 Output voltage regulation and/or control

5.3.2.1 In order to maintain the nominal voltage above, the charger shall allow for the output voltage adjustment in the following ways:

- 5.3.2.1.1 Manual (Local and Remote/SCADA) and
- 5.3.2.1.2 Automatic

5.3.2.2 When the battery charger is subjected to an AC input specified in 5.2, the float voltage regulation from 0% to 100% of full load variation shall not exceed +/-0.5%. The Boost and Equalize voltage regulation shall be within 1% of the nominal input voltage.

5.3.2.3 Unless the output voltage is automatically or anyhow adjusted to meet the batteries' requirements need not to be met.

5.3.2.4 The battery charger shall have extra terminals for connecting an additional battery bank in a case where the main battery bank is disconnected for maintenance purposes.

5.3.3 Parallel operation

5.3.3.1 If so specified, the battery chargers shall be capable of running in parallel with each other.

5.3.4 Ripple voltage limits with resistive load

- 5.3.4.1 When a charger is tested in accordance with 5.10 of SANS 1652:2013, the ripple voltage generated by the battery charger at the DC output terminals shall be within the acceptable values. For this condition, the battery charger shall feed the resistive load of up to 100% of the rated full load DC output current, with the batteries disconnected.

5.3.5 Ripple current limits during charging of lead-acid batteries.

- 5.3.5.1 When measured in accordance with 5.10 of SANS 1652:2013, the maximum r.m.s. ripple current to the batteries shall, in a case of valve-regulated cells, be within the acceptable limits.
- 5.3.5.2 In the case of vented cells, the maximum r.m.s. ripple current to the batteries, when measured in accordance with 5.10 of SANS 1652:2013, shall not exceed the following values:
- 5.3.5.2.1 5A per 100A.h of the battery capacity during the float charge, and
- 5.3.5.2.2 20A per 100A.h of the battery capacity during boost and equalize charge.

5.3.6 Current limiting facility

- 5.3.6.1 A battery charger shall have a current limiting facility/device that limit its total output to the full value of its **rated output current**.
- 5.3.6.2 The battery charger shall be capable of starting up and operating continuously at its **rated output current** without incurring any damages or causing the operation of protective devices.
- 5.3.6.3 The battery charging current shall be limited automatically to the preselected current values for all modes of operations.
- 5.3.6.4 The battery charger shall be capable of feeding into a short-circuit, without incurring any damage, until the protective device operates. This protection shall be tested in accordance with 5.9 of SANS 1652: 2013.

5.3.7 Rated output current

- 5.3.7.1 The following battery charger information shall be specified in **Schedule A**:
- 5.3.7.1.1 The rated output current of a battery charger,
- 5.3.7.1.2 The load current or duty cycle detailing the maximum currents,
- 5.3.7.1.3 The maximum charge current to the batteries for each range (see **5.3.1.**) and
- 5.3.7.1.4 The number of output circuits required from the charger.
- 5.3.7.2 When operating in the constant current mode, the current variation shall not exceed +/-5%.

5.3.8 Radio frequency interference

- 5.3.8.1 The battery charger shall comply with the limits radio frequency interference, as given in the SANS 211. The test shall be conducted with the battery charger feeding into a resistive load under the most onerous (extreme) conditions.

5.3.9 Direct current (DC) system earthing

- 5.3.9.1 All exposed non-current carrying parts shall be earthed onto the earth bar using standard bare or green and yellow PVC insulated copper conductors.
- 5.3.9.2 An earthing point shall be provided and clearly indicated on the external casing/enclosure.
- 5.3.9.3 The neutral (grounded circuit conductor) shall be connected to the equipment's safety-earthing conductor and to the local earth which shall be directly connected to the station earth.
- 5.3.9.4 The earthed conductor from the neutral shall be connected to the earthing conductor at the source and not at any other point to prevent an earth fault protection from being ineffective.

5.3.10 Controls, alarms and instruments

- 5.3.10.1 Whether or not the load is to remain connected when the battery is on equalize charge, will be specified in **schedule A**.
- 5.3.10.2 In a case where a load cannot operate at the equalize voltage, the load shall be connected through a suitable voltage dropping device to ensure that DC output voltage at the load is not exceeded.
- 5.3.10.3 The maximum and minimum voltage that the load can tolerate shall be specified in **schedule A**.
- 5.3.10.4 To prevent damage to the battery, a timer with a setting range of up to 24h shall be provided to automatically switch off the equalize charge.
- 5.3.10.5 Status indications and abnormal operating (alarms) conditions shall be indicated by means of visual and audible signals locally and via SCADA to system operator and/or secondary plant officials:

5.3.10.5.1 Group 1 (Red)

- **Charger output failure alarm** – *Indicates loss of battery charger DC output for any reason, such as transformer failure, tripped circuit breakers, rectifier failure or any other shutdown.*
- **Low DC voltage alarm** – *Indicates that the DC output voltage has decreased below a pre-set, adjustable level.*
- **High DC voltage shutdown alarm** – *Indicates high DC output voltage shutdown and a facility to shut down the battery charger if the output voltage exceeds a pre-set value. If the lock out facility is required, the time delay and voltage requirements shall be specified in **schedule A**.*
- **AC Power alarm** – *Indicate the loss of AC power, the loss of one or more phases of the AC input, incorrect phase sequence, or AC input exceeding the limits in **5.2**.*
- **Load disconnected alarm** – *Indicates that the load has been disconnected from the battery charger.*
- **Battery loss alarm** – *Indicates that the battery has been disconnected from the battery charger output terminals.*
- **Over temperature alarm** – *Indicates that the temperature inside the charger has exceeded the limits indicated in **5.1**.*
- **Rectifier loss of supply alarm** – *Indicates the loss of supply to the rectifier element (MCB tripped or fuse operated).*

5.3.10.5.2 Group 2 (Amber)

- **High DC voltage alarm** – *Indicates that the DC output voltage has increased above the pre-set, adjustable level.*
- **Output voltage ripple alarm** – *Indicates when the output voltage ripple exceeds a predetermined value specified in schedule A.*
- **DC earth fault alarm** – *Indicates an earth fault condition on either the positive or the negative side, for the batteries with floating positive or negative poles or for the batteries with an artificial mid-point earth.*
- **Charger on equalize indicator** – *Indicates when the charger is operating under equalize conditions.*

5.3.10.5.3 Group 3 (Green)

- **Charger on float indicator** – *Indicates when the charger is operating on float condition.*

5.3.10.6 The following controls shall be available on the facia of the charger:

- Alarm reset
- Lamp test if not LCD display.

5.3.10.7 The charger shall have digital instruments (with accuracy of class 1% or better) on the facia of the charger showing or reading the following:

- AC Supply Voltage
- AC supply Current
- DC Charger Current
- DC Battery Voltage
- DC Battery Current

5.3.10.8 The other important quantities measured shall be accessed on the charger's microprocessor/intelligent relay through:

- Local HMI
- Local and Remote Engineering access and
- SCADA.

5.3.10.9 The charger's micro-processor shall be capable of storing at least 100 time and date stamped events (all unhealthy alarms as outlined in 5.3.8.5, isolations, charging status changes, etc.) on a first in first out principle.

6. COOLING REQUIREMENTS

6.1 The charger shall utilize air convection cooling method.

6.2 The cooling method shall be sufficient to continuously maintain a temperature inside the charger cabinet to below 40°C.

6.3 The charger shall be equipped with appropriate monitoring devices/equipment which must automatically issue an over temperature alarm as per 5.3.10.5.1 to:

- 6.3.1 Local HMI
- 6.3.2 Local and Remote Engineering access and
- 6.3.3 SCADA.

7. COMPONENTS

7.1 Transformers and reactors

7.1.1 Transformers shall be double wound dry type, with the primary galvanically isolated from the secondary winding(s).

7.1.2 Windings of transformers (and smoothing reactors if any) shall be treated to exclude moisture.

7.1.3 The insulation systems for transformers (and smoothing reactors if any) shall be suitable for use within the temperature limits specified in SANS 60146-1-3 and shall comply with the Dielectric strength tests when tested in accordance with SANS 1652.

7.2 Semiconductors

7.2.1 Semiconductor rectifying elements used in the converter stage shall be adequately rated for their particular applications and to withstand the surge conditions on the AC inputs and the effects of a short circuit on the output.

7.2.2 Due to their robustness (i.e. high power, high current ratings, etc.), accurate current controllability and lower power losses, the rectifying semiconductors preferred are Thyristors.

7.2.3 Semi-conductors used in AC/DC rectifier stage shall be protected either by high-speed, high-rupturing capacity (HRC) fuses in accordance with the requirements of SANS 60269-4 or by current limiting circuit breakers.

7.3 Printed circuit boards

7.3.1 Printed circuit boards shall be:

- 7.3.1.1 made of material similar to epoxy fibre glass laminate, or better.
- 7.3.1.2 suitably protected from effects of moisture and dust.
- 7.3.1.3 marked to allow the board type and each individual component to be readily identified.
- 7.3.1.4 easily replaceable.
- 7.3.1.5 where it is secured by screws or bolts, access to these screws or bolts shall not be obstructed except by the enclosure.
- 7.3.1.6 provided with rigid and positive support.

7.3.2 Each plug-in board shall be polarised by means of a mechanical key, to prevent a card from being plugged into the wrong socket or inserted upside down.

7.4 Electronic components

7.4.1 All electronic components shall be of industrial grade. Electrolytic capacitors shall in addition, comply with the requirements of IEC 91071 or similar acceptable standards.

7.5 Audible noise level

7.5.1 The A-weighted sound power level, in decibels (dB(A)), emitted by a battery charger shall not exceed the recommended sound levels for different areas of occupancy/activity in non-residential indoor spaces as specified in table 1 of SANS 10103.

7.5.2 When a battery charger is tested in accordance with the Audible Noise Level Test as per SANS 1652, the A-weighted sound power level emitted by the battery shall not exceed the value specified in 7.5.1.

7.6 Construction requirements

7.6.1 The enclosure

- 7.6.1.1 The battery charger shall be housed in a metallic enclosure with all its parts (i.e. doors, hinges, casings, lids, covers, etc.) being adequately thick to provide strength and rigidity to prevent distortion.
- 7.6.1.2 Provision shall be made for the front and side opening the enclosure to allow service access to all components that could require maintenance or replacement, without having to dismantle any other part of the circuitry as per schedule A.
- 7.6.1.3 Further provision be made for the opening to facilitate cabling in a visibly uncluttered and safe manner as per schedule A.
- 7.6.1.4 All parts that carry hazardous voltage shall be shrouded or screened to prevent accidental contact with a service personnel and shall have warning labels as per clause 4.5.1.5 of SANS 1652.
- 7.6.1.5 The enclosure shall have openings to natural ventilation. The openings shall afford a degree of protection of at least IP2X, in accordance with IEC 60529.
- 7.6.1.6 It shall not be possible to remove casing, lid, cover or similar components without using a tool or a key.
- 7.6.1.7 Facilities shall be provided for easy handling and transportation of the battery charger, such as removable lifting devices, or for forklift handling, or other acceptable methods.

7.6.2 Protective earthing

- 7.6.2.1 The battery charger shall be provided with a clearly identified earth terminal. The earthing terminals shall be permanently and indelibly marked with the earth symbol as per SANS 60947-1 with black lines on a yellow background. All The non-current carrying metal parts shall be electrically connected to this terminal.
- 7.6.2.2 The earthing conductors may be bare or insulated. If they are insulated, the insulations shall be green/yellow.

- 7.6.2.3 In a case of braided earthing straps, they may have transparent insulation.
- 7.6.2.4 The earthing terminal shall be placed next to the AC input terminals.
- 7.6.2.5 The current rating of the earthing terminal shall be at least that of the earth fault rating of the input or output cables connected to the battery charger.
- 7.6.2.6 The clamping means of a protective earthing terminal shall be locked against accidental loosening or disconnection. It shall not be possible to loosen the clamping means without the use of tools.

7.6.3 Terminations and terminals

- 7.6.3.1. The position, size and arrangement of input and output terminations shall be subject to an agreement between City Power and the supplier.
- 7.6.3.2. The dimensions of mounting rails shall be to DIN standards or equivalent.
- 7.6.3.3. Terminals shall be provided for all external alarms as per **5.4**.
- 7.6.3.4. Plug-in type edge connectors or connection plugs used for terminals for printed circuit board (PCBs) shall be subject to an agreement between City Power and the supplier.
- 7.6.3.5. The required conductor sizes for the AC input cable and DC output cable shall be adequately sized to meet the demand as per the ratings of the charger.

7.6.4 Internal Wiring

- 7.6.4.1. The internal conductors between the charger terminals and its load terminals shall comply with the relevant parts of SANS 1507.
- 7.6.4.2. The nominal cross-sectional area of internal conductors shall be such that the maximum permitted temperature rise of the conductors insulation is not exceeded.
- 7.6.4.3. Wireways or trunking shall be smooth and free from sharp edges. Conductors shall be so protected from making contact with parts such as burrs, hot or movable/moving parts that can damage conductor insulation.
- 7.6.4.4. Holes in metal through which insulated conductors pass, shall have smooth, well-rounded surfaces and shall have bushings or grommets.
- 7.6.4.5. Wiring shall be neat and shall be braced, placed in a trunking, and clipped or laced (or both) to prevent vibration and to ensure that it does not deform under through fault conditions.
- 7.6.4.6. Connections to equipment on swing doors shall be so arranged as to give the conductor a twisting motion and not a bending motion.
- 7.6.4.7. Bare conductors shall be rigid and fixed or arranged such that under normal operating conditions creepage distances cannot be reduced below values specified in (4.6.1) SANS 1652:2013.

7.6.5 Protection of internal wiring and electronic equipment

- 7.6.5.1. In a battery charger, all internal wiring, including busbars, interconnecting cables, rectifiers and transformers, shall be protected against excess currents and short-circuits by adequately rated overload protective devices that form an integral part of the battery charger.
- 7.6.5.2. Short runs of wiring not involved in the distribution path direct are exempt from the above mentioned requirements where it can be shown that no safety hazard is involved (e.g. indicating circuit)

NOTE: Devices for overload protection of components can also provide protection of associated wiring, internal branch circuits might require individual protection, depending on reduced wire size and length of conductors.

7.6.6 Cable gland plates

- 7.6.6.1. Enclosures shall be designed for ease of access for the purposes of terminating and connecting cables.
- 7.6.6.2. Where so specified in **schedule A**, provision shall be made for insulated gland plates to allow cable screens to be separately earthed. In this case, the earthing terminal shall have provision for cable armouring to be galvanically connected.
- 7.6.6.3. Cable gland plates shall be removable and shall be made of corrosion-protected steel; they shall be left undrilled or, if so specified in **schedule A**, shall be drilled.

NOTE: Among acceptable methods of treatment against corrosion are phosphating, galvanizing, sherardizing, zinc impregnation, and plating or spraying with copper, nickel, cadmium, silver, tin or zinc.

7.6.6.4. A drawing of the gland plate shall be provided before installation. The number of the drawing shall be stated in **schedule B**.

7.6.7 Bolts, nuts, screws and washers

7.6.7.1. All bolts, nuts, screws and washers used in the construction of a battery charger shall comply with the requirements of ISO 4014, ISO 4015, ISO 4016, ISO 4017, ISO 4018, ISO 4032, ISO 4033, ISO 4034 and ISO 4035, and shall be intrinsically corrosion-resistant metal or shall have been so treated to as to render them resistant to corrosion.

7.6.7.2. Spaced-thread (sheet metal) or thread-cutting (self-tapping) screws shall not be used.

7.6.8 Workmanship and finish

7.6.8.1. If City Power has documented standards for workmanship and finish, these should be in **schedule A** and should be included in the enquiry documents.

7.6.8.2. If is registered as working to SANS 9001, this should be stated in **schedule B**.

7.6.9 Colour

7.6.9.1 All external and internal surfaces of the enclosure shall be finished in light grey colour and mounting chassis & plate's surfaces shall be cloud white colour.

7.6.9.2 The paint/coating processes adopted shall take into account of the intended conditions of use, the environment and the maintenance of the battery charger.

7.6.9.3 The paint/coating finish shall be smooth, uniformly applied and free from defects.

7.7 Safety requirements

7.7.1 Clearances and creep distances

7.7.1.1. All apparatus that forms part of a battery charger shall have clearances creepage distances that comply with those given in a relevant SANS or IEC standard.

7.7.1.2. These distances shall be maintained during normal service conditions.

7.7.1.3. The apparatus within a battery charger shall be so arranged that the specified clearances and creep distances are complied with, taking into account the relevant service conditions.

7.7.1.4. For bare, live conductors and terminations (e.g. busbars, interconnections between components, cable lugs, etc.), the clearances and creepage distances shall at least comply with those specified for the apparatus with which they are immediately associated.

NOTE: Recommendations regarding the measurement of clearances and creepage distances are given in annexure F of SANS 60950-1.

7.7.2 Fault ratings

7.7.2.1. Busbars and conductors between the busbars and the supply side of a single functional unit shall be rated to withstand the combined fault currents of both the charger and the battery for the time required by the protective device to clear the fault.

7.7.2.2. All components and interconnections shall be protected by moulded circuit breakers (MCCB's) against fault currents within their circuits or in the AC input or DC output circuits. When so specified in **schedule A**, the battery charger shall be protected against a reversed battery connection. This shall include protection of all auxiliary circuits within the battery charger. The methods of protection shall be stated in **schedule B**.

7.8 Maintenance and spares

7.8.1 The supplier shall specify the maintenance required for the battery charger supplied.

7.8.2 The maintenance equipment and tools shall comply with SANS 1652.

7.8.3 A comprehensive, individually priced spare parts list shall be provided by the supplier before delivery, to allow City Power to request any spares to be delivered with the charger.

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- 7.8.4 The supplier shall maintain spare parts for the battery charger for a period of ten years from the date of delivery and shall guarantee this in schedule B.

8. TESTS

- 8.1. All components shall be tested in accordance with SANS 1652.
- 8.2. Full operational tests are to be conducted after the installation on site by a manufacturer's qualified engineer.

9. MARKING/LABELLING/DOCUMENTATION

- 9.1 The rating plates, functional labels and identification of external terminals shall be compliant to SANS 1652.
- 9.2 The standard danger notice (type WW of SANS 1186-1) shall be prominently outside and inside the enclosure and shall be readily visible when the charger is installed for normal service.
- 9.3 The supplier shall provide the following documentation in hard and softcopies:
 - 9.3.1 A final schematic diagram with all parts suitable identified,
 - 9.3.2 A wiring diagram, showing the "as installed" connections,
 - 9.3.3 Installation instructions,
 - 9.3.4 An instruction manual (with a complete set of drawings of the charger) containing comprehensive instructions for the operation of the battery charger,
 - 9.3.5 Fault tracing guide and maintenance instructions.
 - 9.3.6 A detailed list of parts and equipment incorporated in the charger, together with their ratings, part number, type and manufacturer,
 - 9.3.7 A dimensional outline drawing and
 - 9.3.8 Routine and type tests certificates and reports.

10. TRAINING AND SUPPORT

- 10.1 A necessary certified training course shall be offered to relevant City Power staff. The training shall include, amongst other things, the handling, storage, safety, operation, maintenance and installation of the battery charger.
- 10.2 The associated costs for the certified training course in 10.1 shall be given per person and shall be fixed for the period of the contract.

11. QUALITY MANAGEMENT

A quality management plan shall be set up in order to assure the proper quality management of the battery charger during design, development, production, installation and servicing phases. Guidance on the requirements for a quality management plan may be found in the ISO 9001:2015. The details shall be subject to agreement between City Power and the Supplier.

12. HEALTH AND SAFETY

A health and safety plan shall be set up in order to ensure proper management and compliance of the battery charger during installation, operation, maintenance, and decommissioning phases. Guidance on the requirements of a health and safety plan may be found in OHSAS 18001:2007 standards. This is to ensure that the asset conforms to standard operating procedures and City Power SHERQ Policy. The details shall be subject to agreement between City Power and the Supplier.

13. ENVIRONMENT MANAGEMENT

An environmental management plan shall be set up in order to assure the proper environmental management of the battery charger throughout its entire life cycle (i.e. during design, development, production, installation, operation and maintenance, decommissioning and disposal phases). Guidance on the requirements for an environmental management system may 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.

Annex A- Bibliography

None

Annex B - Revision information

DATE	REV. NO.	NOTES
March 2008	0	First issue
April 2020	1	Second issue
		Format changed
		General editing
		Inclusion of Quality Management
		Inclusion of Health and Safety Management
		Inclusion of Environmental Management

Annex C - Technical schedules A and B for battery charger

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Sub-clause CP_TSSPEC _160	Description	Schedule A	Schedule B
1	5.1	Service Conditions	XXXX	
	5.1.1.1	Indoor Yes/No	Yes	
	5.1.1.2	Altitude (above sea level) m	1800	
	5.1.1.3	Maximum ambient temperature °C	40	
	5.1.1.4	Minimum ambient temperature °C	-10	
	5.1.1.5	Relative humidity Max. %	90	
	5.1.1.6	High lightning area Yes/No	Yes	
2	5.2	Alternative current input	XXXX	
	5.2.1	Input characteristics	XXXX	
	5.2.1.1	Nominal voltage V	400±10%	
	5.2.1.2	Nominal frequency Hz	50	
	5.2.1.3	AC input system property earthed according to SANS 1652? Yes/No	Yes	
	5.2.2	Primary power isolation	XXXX	
	5.2.2.1	Provision made to isolate charger primary supply Yes/No	Yes	
	5.2.2.2	Padlock operated locking facility supplied Yes/No	Yes	
	5.2.2.3	Disconnecting device comply with SANS 60947-3 Yes/No	Yes	
	5.2.4	Protection against lightning surges	XXXX	
	5.2.4.1	As per table 1 Yes/No	Yes	
3	5.3	Direct current (DC) output	XXXX	
	5.3.1	Output characteristics as per clause 5.3.1 Yes/No	Yes	

NOTE: TICKS [✓✗], ASTERISK [*], WORD [NOTED], OR TBA [TO BE ADVISED] WILL NOT BE ACCEPTED.

Tender Number: _____

Tenderer's Authorized Signatory: _____
 Name in block letters Signature

Full name of company: _____

Annex C - Technical schedules A and B for battery charger (Continuous)

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

Item	Sub-clause CP_TSSPEC _160	Description	Schedule A	Schedule B
	5.3.2	Output voltage regulation and/or control	XXXX	
	5.3.2.1	Output voltage adjustment	XXXX	
	5.3.2.1.1	Manual (Local and Remote/SCADA) Yes/No	Yes	
	5.3.2.1.1	Automatic Yes/No	Yes	
	5.3.3	Parallel operation	XXXX	
	5.3.3.1	Battery chargers capable of running in parallel? Yes/No	Yes	
	5.3.6	Current limiting facility	XXXX	
	5.3.6.1	Battery chargers has current limiting facility? Yes/No	Yes	
	5.3.6.2	Battery chargers capable of starting up and operating continuously ? Yes/No	Yes	
	5.3.6.3	Battery chargers capable to limit pre-selected current values automatically? Yes/No	Yes	
	5.3.6.4	Battery chargers capable of feeding into a short-circuit without incurring any damage as per clause 5.3.6.1? Yes/No	Yes	
	5.3.7	Rated output current complies with clause 5.3.7 Yes/No	Yes	
	5.3.8	Radio frequency interference complies with clause 5.3.8 Yes/No	Yes	
	5.3.9	Direct current system earthing complies with clause 5.3.9 Yes/No	Yes	
	5.3.10	Controls, alarms and instruments complies with clause 5.3.10 Yes/No	Yes	
4	6	Cooling requirements complies with clause 6 Yes/No	Yes	

NOTE: TICKS [✓✗], ASTERISK [*], WORD [NOTED], OR TBA [TO BE ADVISED] WILL NOT BE ACCEPTED.

Tender Number: _____

Tenderer's Authorized Signatory: _____

Name in block letters Signature

Full name of company: _____

Annex C - Technical schedules A and B for battery charger (Continuous)

Schedule A: Purchaser's specific requirements

Schedule B: Guarantees and technical particulars of equipment offered

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NOTE: TICKS [✓✗], ASTERISK [*], WORD [NOTED], OR TBA [TO BE ADVISED] WILL NOT BE ACCEPTED.

Tender Number: _____

Tenderer's Authorized Signatory: _____

Name in block letters Signature

Full name of company: _____

Technical schedules A and B for battery charger
Deviation schedule

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 City Power.

Item	Sub-clause	Proposed deviation

Tender Number: _____

Tenderer's Authorised Signatory: _____
Name in block letters Signature

Full name of company: _____

Annex D – Stock Items

It is not intended that City Power should keep stock of these items.