TRANSNET freight rail

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

REQUIREMENTS FOR BATTERY CHARGERS FOR 3kV DC TRACTION SUBSTATIONS.

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1.0 SCOPE.

1.1 This specification covers the requirements for the design, manufacture and supply of battery charger units used in 3 kV DC traction substations.

2.0 GENERAL.

2.1 The equipment is required to charge a 53 cell lead acid 3 kV DC substation or tie station battery bank. The ampere-hour rating of the battery bank may vary between 100 to 250 ampere hours. The charger must be able to supply the substation or tie station load as well as float charge the battery under normal conditions.

2.2 The battery could be subjected to momentary heavy discharges from 50 amperes to 250 amperes for a period of 1 to 3 seconds. The discharge current is for the closing coils of the 3 kV DC high-speed circuit breakers. The discharge current is dependent of the model of the circuit breaker used.

2.3 In addition to charging the battery bank the charger must supply a constant voltage to the high-speed circuit breaker's holding coils. As the trip calibration of the high-speed circuit breakers is dependent on the holding coil voltage, the voltage must be maintained at 110 volts by means of a suitably tapped diode string or other means. In the event of failure of the battery charger, the diode string shall be automatically short-circuited and the holding coils of the track breakers shall be fed directly from the battery.

3.0 STANDARDS.

The following latest editions of the following publications are referred to herein.

3.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 1091:	National colours standards for paint.
SANS 1274:	Coatings applied by the powder-coating process.
SANS 1652:	Battery chargers – Industrial type

3.2 TRANSNET FREIGHT RAIL.

BBB0041:	Preparation of drawings for Transnet Freight Rail infrastructure.
CEE.0045:	Painting of steel components of electrical equipment.
CEE.0224:	Drawings, catalogues, instruction manuals and spares lists for electrical equipment supplied under contract.

4.0 DEFINITIONS

4.1 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.

4.2 FLOAT CHARGE: A constant voltage charge ideally sufficient to maintain a cell or battery in a fully charged state.

4.3 EQUALISING CHARGE: An extended charge applied to correct relative density imbalance amongst the cells of a battery.

4.4 INITIAL CHARGE: An increased charge for new or uncharged battery cells.

5.0 TENDERING PROCEDURE

5.1 Tenderers shall indicate clause by clause compliance with the specification. This shall take the form of a separate document listing all the specifications clause numbers indicating the individual statement of compliance or non-compliance.

5.2 A statement of non-compliance shall be motivated by the tenderer.

5.3 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

5.4 Failure to comply with clauses 4.1, 4.2, and 4.3 could preclude a tender from consideration.

6.0 SERVICE CONDITIONS.

The battery charger shall be designed to operate under the following service conditions.

6.1	Altitude:	0 – 1800 meters above sea level.
6.2	Ambient Temperature Range:	-10°C to +45°C.
6.3	Relative Humidity:	10% to 90%
6.4	Lightning Conditions:	12 Ground flashes per square kilometre per annum.

7.0 ELECTRICAL REQUIREMENTS

7.1 INPUT VOLTAGE.

7.1.2 The charger must be capable of working off an auxiliary supply with a poor waveform, as a result of thyristor controlled locomotives, line switching and lightning induced surges. A total harmonic voltage distortion figure of 27% must be catered for.

7.1.3 Appendix 1 shows the Quality of Supply characteristics of a typical 230 Volt AC auxiliary supply of a 3 kV DC traction substation.

7.1.4 The battery charger output shall be fitted with low pass filtering to reduce the effect of harmonic frequencies and ripple on the battery and load circuits.

7.2 The following input supplies are available at the 3 kV DC traction substations.

1. Single phase 230 volts AC ± 10% (r.m.s)
2. Three phase 400 volts AC ± 10% (r.m.s)
3. Frequency 50Hz ± 2Hz.

7.3 OUTPUTS.

7.3.1 The charger must be capable of driving varying loads and be unaffected by sudden changes in load current and transients generated by the load.

7.3.2 With no battery connected to the output, the charger must be capable of withstanding a short-circuit across its terminals, without any resultant component damage.

7.3.3 The conductors of the battery charger output must be rated to carry the maximum load current continuously. For a 100 ampere hour battery bank, 35 milli meter square conductors are recommended to make provision for short circuit ratings.

7.3.4 Upon switch on, the charger must incorporate a soft start feature, so that at no time either the DC output current or voltage exceeds their full load values.

7.3.5 The charger outputs shall be voltage and current limited for "float" and "boost" charging.

7.4 OUTPUT PARAMETERS.

The following parameters shall be complied with:

7.4.1 SYSTEM DC VOLTAGE.

7.4.1.1 The nominal voltage shall be 110 volts.

7.4.1.2 The charging battery voltage shall be 110volts to 119.25volts for the automatic mode. (2.25volts per cell).

7.4.1.3 The charging battery voltage shall be 110 volts to 127.2 volts for the boost mode. (2.35 volts to 2.40 volts per cell)

7.4.2 TOTAL CURRENT

7.4.2.1 The output current shall be 30 ampere (current limit in the automatic mode)

7.4.2.2 The current shall be 5 ampere to 25 ampere in the boost mode.

7.4.3 LINE REGULATION

7.4.3.1 The line regulation shall be a maximum of 0.75% when the input varies ± 10%.

7.4.4 RIPPLE VOLTAGE

7.4.4.1 For all output current up to 100% battery charger capacity into a resistive load:
The maximum peak to peak ripple voltage at the charger output terminals (with resistive load coupled to the output terminals instead of the battery) shall not exceed 5% of the nominal battery voltage.

7.4.4.2 The peak to peak ripple voltage shall be measured at nominal input voltage.

7.4 .5 RIPPLE CURRENT

7.4.5.1 The maximum peak to peak ripple (AC) voltage measured across the shunt for the total current shall not exceed 5% of the nominal battery voltage.

7.4.5.2 The peak to peak ripple current shall be measured at nominal input voltage.

7.4.5.3 The maximum superimposed r.m.s value of the AC component shall always have a positive value even if it is very small i.e. 100 milli ampere. The AC ripple shall be limited to 5% of the ampere hour rating capacity expressed in amps for example 5 ampere or less for a 100 ampere hour battery bank.

7.4.5.4 The battery charger shall meet the requirement that the charging current never becomes negative (discharge) in value.

7.4.6 DC OUTPUT CHARGE VOLTAGE

7.4.6.1 The DC output voltage must remain within ± 1% of the respective value for boost and float modes and within 5% for initial charge mode.

7.4.7 FLOAT MODE

7.4.7.1 The output voltage shall be pre-set at 2,25 volts per cell but adjustable by ± 5%. For 53 cells the float voltage shall be 119,25 volts adjustable. The values shall be within 1% in the automatic mode.

7.4.8 BOOST MODE

7.4.8.1 The output voltage shall be pre-set at between 2,35 volts to 2,40 volt – 5% per cell, adjustable. For 53 cells the boost voltage shall be set at 124,55 volts. (2,35 volts per cell) to 127.2 volts (2.40 volts per cell). The boost voltage shall remain within 1% of the required boost voltage. In automatic operational mode the battery charger shall revert back to float charge mode when the boost charge cycle is completed.

7.4.9 MANUAL BOOST MODE

7.4.9.1 A push button is required to switch the charger to "boost mode" manually. The battery charger shall revert back to float charge mode when the boost charge cycle is completed i.e. when the set boost voltage is reached. (124.55 volts to 127.2 volts). An additional push button shall be provided to be able to cancel the boost mode when required.
An adjustable 0-4 hour timer shall be installed to automatically switch off the manual boost in the event of the manual boost mode not being switched off by the technical staff.
After the boost mode has being switched off, the charger shall remain in the trickle charge mode for a period of not less 30 minutes before changing back to automatic boost mode if the battery voltage has not reached the required float voltage.

7.4.10. AUTOMATIC BOOST CHARGE.

7.4.10.1 The battery charger shall initiate an automatic boost charge every 28 days to ensure maximum life and reliability of the battery. The battery charger shall revert back to float charge when the battery is fully charged.

7.4.11 CURRENT LIMITING

7.4.11.1 Current limiting is required for the battery charger current. In float and boost modes these limits must be downward adjustable by 25% of the maximum values.
The charger shall control limits within ± 5% of the adjustable value.

7.5 EFFICIENCY

7.5.1 The efficiency shall not be less than 60% for single phase chargers at maximum charger output capacity.

7.5.2 The efficiency shall not be less than 70% for three phase chargers at maximum charger output capacity.

7.6 INPUT TRANSFORMER.

7.6.1 The main power transformer shall incorporate an electrostatic screen between the primary and secondary windings. The screen shall be connected to the frame.

7.7 ELECTRONIC CIRCUITRY.

7.7.1 PRINTED CIRCUIT BOARDS

Printed circuit boards shall comply with the following requirements in accordance to SANS 1652:

7.7.1.1 They shall be made of material similar to epoxy fibreglass laminate or better.

7.7.1.2 They shall be suitably protected from the effects of moisture and dust.

7.7.1.3 They shall be marked to allow the board type, and each individual component to be readily identified.

7.7.1.4 Printed circuit boards shall be provided with rigid and positive support and shall be easily replaceable.

7.7.1.5 The plug-in-boards shall be polarised to prevent the plug-in-boards being plugged into a wrong socket or being inserted upside down.

7.8 CONTROL AND ALARM SETTINGS.

The battery charger shall be fitted with the following alarms and alarm relays:

7.8.1 Charger low voltage alarm between 90 volts and 105 volts adjustable. Relay to be fitted for flag operation when relay is de-energised.

7.8.2 Charger high volt alarm. (Float). This alarm is pre-set just above normal float voltage. This alarm allows boost charging while providing protection against overcharging. Relay to be fitted. (127.2 volts).

7.8.3 Charger high volt alarm. (Boost). This alarm level is pre-set just above normal boost volts. When the normal boost voltage is exceeded the boost mode shall be terminated and a high volt alarm and relay contacts shall be initiated.

7.8.4 Battery charger input voltage mains failure relay and contacts.

7.9 ILLUMINATED INDICATORS.

7.9.1 Only Light Emitting Diodes (LED's) are to be used.

7.9.2 The following colours for the LED's shall be used:

Green: Normal condition. Mains on.
Red: Fault condition. Battery voltage low, high volts etc.
Amber: To indicate a specific status e.g. Boost charge, Initial charge.

7.10 METERS.

7.10.1 VOLTMETER

7.10.1.1 The digital Voltmeter shall be able to measure between 80 volts to 150 volts. The display shall be 3.5 digits, 12 milli meters high with an accuracy of ± 0.5%.

7.10.1.2 The digital Voltmeter shall be connected so that it can measure both the battery voltage and the high speed circuit breaker holding coil voltage. A high quality two-way selector switch shall be employed and mounted on the face of the battery charger.

7.10.2 AMMETER

7.10.2.1 The digital ammeter shall be 3.5 digits, 12 milli meters high with an accuracy of ± 0.5%, class 0.5. The ammeter shall measure shall measure the total charger current by means shunt sensing.

7.10.2.2 The ammeter shall be connected so that it can measure total current and battery charging current. A high quality two-way selector switch shall be employed and mounted on the face of the battery charger.

7.10.2.3 The markings for both voltage and current positions shall be by means of labels, which are riveted or screwed to the face of the panel.

7.10.2.4 Both Voltmeters and ammeters shall be protected against transients and surges. Suitable protection circuitry such as metal oxide varistors and resistance capacitance circuits shall be fitted to the input leads of the meter.

7.11 LIGHTNING AND SURGE PROTECTION

7.11.1 The equipment shall be fitted with surge and lightning protection on the input AC supply to the charger. The supplier shall provide circuitry or protection units for this purpose. Separate external modules are acceptable for protection. The protection circuitry shall consist of a combination of resistors, capacitors, metal oxide varistors and gas arresters. Dehnventile type or equivalent protection will be preferred.

7.12 HIGH SPEED CIRCUIT BREAKER SERIES DROPPING DIODES.

7.12.1 A regulated supply is required for the high speed circuit breaker holding coils. Suitably rated series dropping diodes shall be employed for this purpose. Refer to clause 2.3.

7.12.2 The charger shall be supplied with a suitably rated series diode dropping chain for the high-speed circuit breakers holding coils. The series diode dropping chain shall be able to be bridged out by means of electrical contactors for regulation purposes as required.

7.12.3 The charger shall be provided with a minimum of three output terminals namely, battery positive, holding coil positive and battery negative.

8.0 CONSTRUCTURAL REQUIREMENTS

8.1 The battery charger shall be a self-contained unit housed in a rigidly constructed sheet metal cubicle, suitable for floor or wall mounting.

8.2 The inside and outside of the cubicle shall be powder coated in accordance with SANS 1274. The coating shall be type 4 for corrosion-resistant coatings for interior use using thermosetting type high gloss coatings. The exterior finishing colour shall be Eau-de-Nil to SANS 1091 colour No H 43 and the interior high gloss white.

8.3 The cubicle shall be adequately ventilated to prevent overheating of the electrical equipment and be vermin-proof. Natural cooling shall be used. The use of cooling fans is not permissible.

8.4 The design and arrangement of the cubicle and equipment shall provide ease of inspection and maintenance.

8.5 The cubicle shall be provided with an earthing terminal welded to the frame to facilitate the connection of a 95mm ^{2} earthing cable using a M12 lug.

8.6 Provision shall be made for suitable cable or conduit entry for the incoming AC supply and DC output supplies.

8.7 The wiring shall be executed in a neat and orderly fashion and shall consist of PVC insulated stranded copper conductors to ensure flexibility and mechanical strength and be suitably rated for the current carrying capacity of the circuits.

8.8 The wiring shall be provided with identification tags at terminals and shall be marked in accordance with the wiring diagrams.

8.9 The control switches, m.c.b's etc mounted on the panel shall be suitably labelled to clearly indicate their function. The lettering of the labels shall consist of white lettering on a black background.

8.10 The labels shall be permanently fixed with screws, rivets or other approved method.

9.0 INSPECTION AND TESTING.

9.1 Transnet Freight Rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.

9.2 Arrangements must be made timeously for such inspections to be carried out before delivery of the equipment to the client.

10.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

10.1 Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Transnet Freight Rail's specification CEE.0224.

10.2 The preparation of the drawings shall comply with Transnet Freight Rail's specification BBB0041

10.3 The tenderer shall supply three copies of instruction/maintenance manuals, schematic diagrams, diode application notes and protection and filter ratings.

10.4 The contractor shall submit details of spares required in accordance with specification No. CEE.0224.

10.5 All spares recommended for normal maintenance purposes that are not available locally (requires importation) must be highlighted.

11.0 SPECIAL TOOLS AND/OR SERVICING AIDS

11.1 Special tools or servicing aids necessary for the efficient maintenance, repair or calibration of the equipment shall be quoted for separately.

11.2 Tenderers shall submit detailed offers for special tools and servicing aids including all specialised equipment required for the servicing and maintenance of the equipment supplied.

12.0 TRAINING

12.1 The tenderer shall submit details with the tender of the training courses, which will be conducted by the contractor for the training of Transnet Freight Rail's maintenance staff in the operation and maintenance of the equipment supplied. The courses shall include theoretical as well as practical tuition. The date and venue of this training course shall be arranged with the maintenance manager.

13.0 GUARANTEE AND DEFECTS

13.1 The contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and installed by him and accept liability for maker's defects, which may appear in design, materials and workmanship.

13.2 The guarantee period for all substations shall expire after: -

A period of 12 months commencing on the date of completion of the contract or the date the equipment is handed over to Transnet Freight Rail whichever is the later.

13.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract e.g., faulty locomotive or overhead track equipment, etc., shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Maintenance manager and at the cost of the Contractor.

13.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the contractor shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet Freight Rail the cost of material and labour

END

APPENDIX 1

QUALITY OF SUPPLY CHARACTERISTICS OF A TYPICAL 230 VOLT AC AUXILIARY SUPPLY'S OF A 3 KV DC TRACTION SUBSTATION.

1. 230 VOLT AC AUXILIARY SUPPLY SERVICE CONDITION

1.1 The auxiliary supply is derived from the tertiary windings within the traction transformer or from the secondary of the traction transformer by means of a step down transformer. Under traction load, i.e. an electric train drawing power from the substation the AC waveform is distorted due to harmonics created by the traction rectifier.

1.2 The Total Harmonic Distortion, which can be expected is up to 27 %.

1.3 A typical voltage waveform, which can be expected, is shown in figure 1 and its corresponding frequency spectrum (FFT) is shown in figure 2.

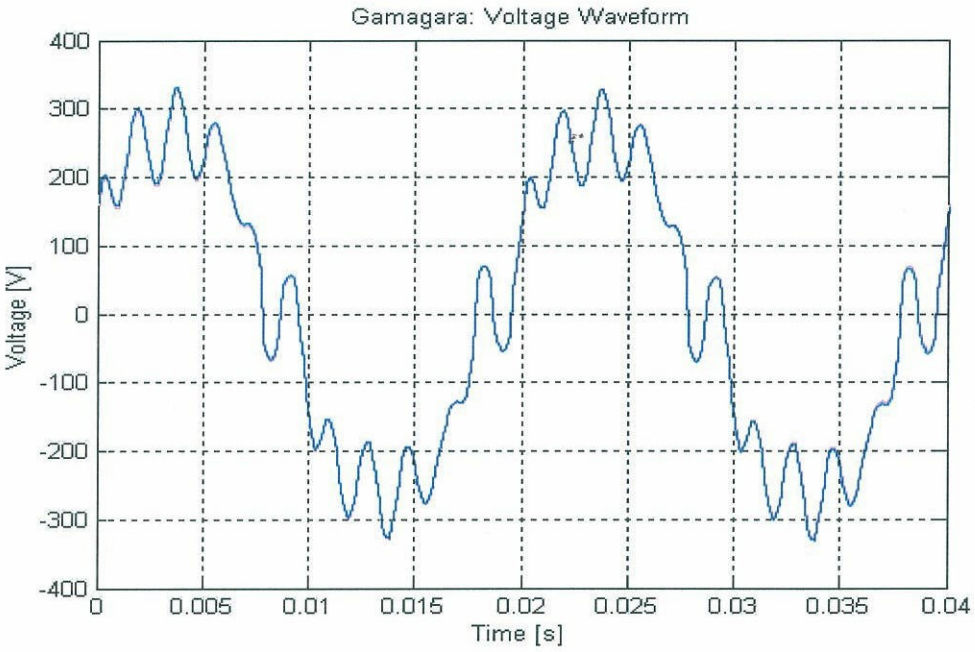


Figure 1: Voltage waveform under traction load (traction = 3000A)

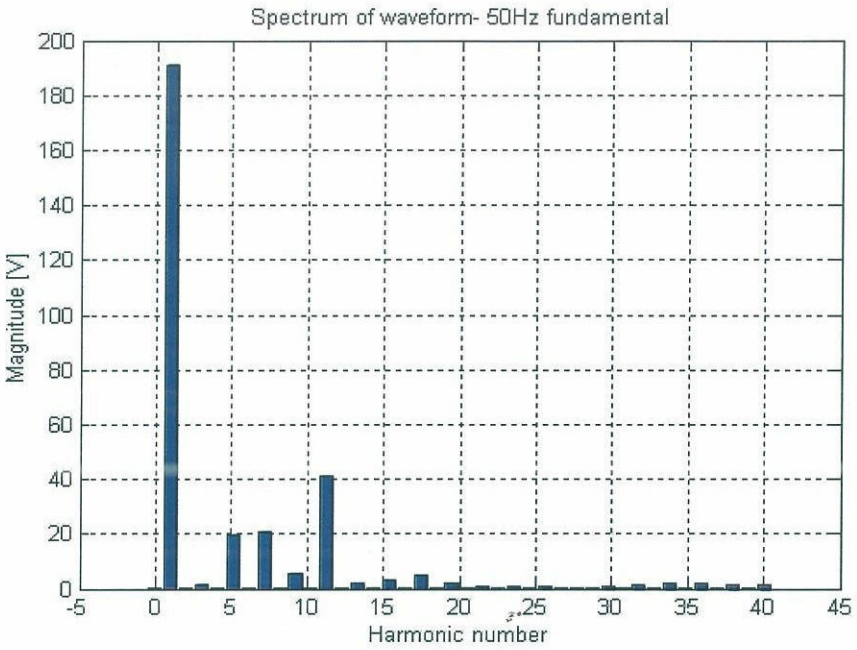


Figure 2: Frequency spectrum (FTT) of voltage waveform as shown in figure 1.

END

APPENDIX 2

TECHNICAL DATA SHEET.

(To be completed by client)

1.0 SUBSTATION NAME: _____

2.0 SUPPLY VOLTAGE: _____

3.0 AMPERE HOUR RATING: _____

4.0 CONSTRUCTION:

FLOOR MOUNTED: YES / NO

WALL MOUNTED: YES / NO

END