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PASSENGER RAIL AGENCY OF SOUTH AFRICA

SPECIFICATION

THE APPOINTED SERVICE PROVIDER MUST MAINTAIN, REPAIR/REPLACE, SUPPLY, DELIVER AND TEST & COMMISSION OF UNINTERRUPTIBLE POWER SUPPLIES (UPS) AND BATTERIES FOR RAILWAY SIGNALING APPLICATIONS.

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APPENDIX A: TECHNICAL DETAIL OF UPS

1. SCOPE

1.1. This specification describes a single-phase and a three-phase solid state 6-pulse modular uninterruptible power supply (hereinafter referred to as UPS) for use in Signal Equipment Rooms, Apparatus Rooms and Level Crossings Cabins. The UPS shall utilise a true “online” topology i.e. connected loads are isolated from irregularities of the mains supply without interruption and supplied from the UPS.

Batteries must be removed from premises without hindrance and effect to existing equipment and installations and in a safe environmentally friendly way in line with ESAP (Environmental Sustainability Action Plan) principles.

NOTE: **UPS and battery replacement timelines:**

The winning bidder is to provide the following:

- technical support on site in less than 2 hours.
- 24-hour technical assistance with first line of maintenance and repairs.
- 6 monthly full UPS and battery service, including a report at the following Power Rooms:

NO	CORRIDOR	ROOM	TYPE
1	South	Cape Town	SER
2		Cape Town	AR 1
3		Cape Town	AR 2
4		Cape Town	AR 3
5		Bay Junction	SER
6		Salt River	SER
7		Mowbray	AR
8		Newlands	AR
9		Retreat	SER
10		Wynberg	AR
11		Plumstead	AR
12		South Field	AR
13		Diep River	AR
14		Steenberg	AR

15		Muizenberg	AR
16	South	Fish Hoek	AR
17		Simonstown	AR
18		Wetton	AR
19		Hazendal	SER
20		Maitland	AR
21		Koeberg	AR
22	North	Woltemade	SER
23		Kensington	AR
24		Parow	AR
25		Goodwood	AR
26		Elsies River	AR
27		Mutual	AR
28		Kuils River	SER
29		Blackheath	AR
30		Eerste River	AR
31		Lynedoch	AR
32		Vlottenburg	AR
33		Stellenbosch	AR
34		Koelenhof	AR
35		Faure	AR
36		Firgrove	AR
37		Somerset	AR
38		Van Der Stel	AR
39		Strand	AR
40		Bellville	SER
41		Bellville	AR
42		Bellville	RM&TCC
43		Koelenhof Khromme Rhee Road	LX Cabin
44		Koelenhof Elsenberg	LX Cabin
45		Stellenbosch Bergkelder	LX Cabin

46		Eerste River Station Road	LX Cabin
47	North	Blackheath Buttskop Road	LX Cabin
48		Serepta Road	LX Cabin
49	South	Beach Road	LX Cabin
50		Kalk Bay	LX Cabin
51		Kenilworth	LX Cabin
52		Military Road	LX Cabin
53		Albertyn Road	LX Cabin
54		York Road	LX Cabin
55		White Road	LX Cabin
56		Auxbridge	LX Cabin

NB Central corridor in the design stage (information still to be confirmed).

2. DEFINITIONS

2.1. The UPS shall denote all the complete power converter modules with associated controls, remote alarm panels, communication and batteries required by the design.

2.2. The Rectifier/Charger shall denote that portion of the power converter module containing the equipment and controls to convert the incoming power to regulated DC power required by the battery charger and inverter.

2.3. The Inverter shall denote that portion of the power converter module, which converts the DC power to precisely regulated AC power required by the critical load.

2.4. The Static Transfer Switch is defined as a switch which can perform an automatic transfer of the critical load from the UPS to the bypass circuit or from the bypass circuit to the UPS.

2.5. The Critical Load Bus denotes the load as presented to the UPS by computers, controllers or other critical loads and associated circuits.

2.6. Successful Transfer is defined as an automatic and uninterrupted transfer of the critical load from, or to the UPS without causing degradation of the critical bus voltage beyond the specified limits.

2.7. Maintenance bypass switching shall denote the capability of manually bypassing the UPS in total and powering the critical load from the bypass source. The bypass switching shall not cause any interruption of the power to the critical load.

2.8. Online topology operation is defined as the isolation of critical loads from the irregularities of the mains supply without interruption and supplied from the UPS.

3. REFERENCES

The following standard specifications are referred to.

- SABS 1474
- SABS EN 50091-1
- SABS EN 50091-2
- IEC950
- IP 22
- SANS 62040-1

4. SERVICE CONDITION

The UPS shall operate within the limits laid down in this specification and shall be capable of withstanding a combination of the following environmental conditions.

4.1. Altitude 0-2000 meters above sea level.
4.2. Ambient temperature 0ºC to 40ºC.
4.3. Relative humidity 95% (non-condensing)
4.4. Maximum altitude without derating shall be 1800 meters above sea level. The derating shall be in the order of not more than 2,0% for every 100 meters above 1800 meters.
4.5. The UPS permitted load shall be derated with continuous operation at high ambient temperature – 20% at 40ºC.

5. SYSTEM OPERATION DESCRIPTION

5.1. The UPS shall provide high quality AC power for electronic equipment loads and shall offer the following features:

- Increased Power Quality
- Improved Noise Rejection
- Compatibility with all types of loads
- Power blackout protection
- Full battery care

5.2. The UPS shall consist of the following major components:

- Rectifier/Battery charger
- Microprocessor controlled transistorised inverter
- Electronic static bypass switch
- Maintenance bypass switch.
- Matching battery cubicle (Optional)

5.3. The operation and control shall be provided through use of microprocessor logic. Indications, measurements and alarms, together with power indications and battery condition shall be shown on a clearly illuminated display. Light emitting displays for battery condition are also acceptable.

6. METHODS OF OPERATION

6.1. *Normal* - In the normal mode the critical load is continuously supplied by the UPS. The rectifier/charger converts the AC power into DC power while simultaneously maintaining the battery in a fully charged operational condition. The inverter converts the DC power into clean and related AC power, which is supplied to the critical load through a static switch.

6.2. *Overload* - In the event of an inverter overload, manual stop, or failure, the static switch shall automatically transfer the critical load to the bypass circuit without interruption. The transfer time when synchronised shall not be more than 500 microseconds. The transfer time without synchronisation shall not be more than 20 milli-seconds.

6.3. *Emergency conditions* - If the AC mains fails or reduces by 20% of the nominal AC main value, the critical load shall be supplied without any switching by the inverter drawing its power from the battery supply.

There shall be no interruption to the supply of the critical load upon failure, reduction or restoration of the AC main supply.

While the UPS is powered by the batteries, information shall be provided of the condition of the state of charge and autonomy time remaining of the batteries.

6.4. *Recharge* - When the AC main source is restored, the rectifier/charger shall automatically restart and gradually assume both the inverter and battery recharge loads and shall cause no interruption to the critical load.

6.5. *Maintenance bypass switch* - The UPS shall be fitted with a manual maintenance bypass switch with which the power section can be disconnected and bypassed for servicing purposes. The bypass switch shall be overrated by 10% of the UPS rating. The UPS shall have clear indication when in manual service bypass mode.

6.6. *Operation without battery* - If the battery is taken out of service for maintenance it shall be disconnected from the rectifier/charger by means of a switch. The UPS shall continue to operate and meet the performance criteria specified except for the standby period.

6.7. *Predictive functions* - In all of the modes of operation, key internal operating parameters such as heat-sink temperatures, cooling air temperatures, voltage, current and load parameters shall be continuously monitored and annunciated.

6.8. *Remote control and monitoring* - The UPS shall have the capability to be monitored and controlled from a remote location. Even during a complete shutdown of the UPS, the information relating to the operating parameters shall not be lost. Non-volatile ram should be able to store the information for up to 7 years. RS 232 using D type connectors shall be employed but other communication such as Ethernet may also be used in addition to the RS 232.

6.9. *Redundant functions* - To ensure maximum reliability the key operating electrical parameters shall be controlled to ensure the safety of the load and the UPS batteries.

The parameters controlled on the load side shall be:

- Voltage Amplitude
- DC Components
- Frequency

The parameters controlled on the battery side shall be:

- Voltage Regulation
- Temperature

6.10. *Parallel configuration* - The UPS shall have the capability to be connected in a parallel configuration between units of the same rating.

When operating under normal conditions the power delivered to the load shall be shared between the numbers of UPS units.

In the event of a failure of one of the UPS units the faulty unit shall be disconnected automatically, and the load shall be supplied from the remaining units without any break in the supply continuity.

The number of UPS units able to be connected in parallel shall be 2, 3, or 4.

7. ELECTRONIC MODULES AND COMPONENTS

All active electronic devices shall be of solid-state construction and shall not exceed the manufacturers recommended operating parameters for maximum reliability.

8. NEUTRAL CONNECTION AND EARTHING

The UPS output AC neutral shall be isolated, except for RFI filters, from the UPS chassis.

9. EMC AND SURGE PROTECTION

Electromagnetic effects shall be minimized to ensure computer and other electronic systems shall not be affected by the UPS.

The UPS shall also be fully protected against transients and surges.

EMC filtering to comply with level B filtering.

10. RECTIFIER/BATTERY CHARGER

10.1. The rectifier/battery charger shall be able to operate with the following types of batteries, dependent on system requirements:

- Sealed

- Vented

The selection of the charging method should be managed by the microprocessor.

10.2. The rectifier shall be of the 6-pulse configuration. This configuration must attenuate the 5th, 7th, 11th and 13th harmonics in order to achieve a total harmonic distortion (THDI) of 5%.

10.3. The rectifier/battery charger output voltage shall not deviate more than 0,5% under the following conditions:
No load to 100% load variation

10.4. The rectifier/battery charger shall have an input power factor of 0, 85 or higher with nominal load, nominal input voltage and in the automatic float charge state.

10.5. The rectifier/battery charger shall have sufficient capacity to recharge the battery to a fully charged condition and support the full load on the inverter.

10.6. The rectifier battery charger shall be automatically switched off if the DC voltage exceeds a maximum preset value.

10.7. The status of the battery shall be tested monthly under the control of the microprocessor. The battery test shall be performed without any risk to the load and shall not cause any degradation in terms of expected life of the battery system.

All relevant measurements shall be shown. (measurement of back-up time, discharge/charge rate etc.)

10.8. When the end of discharge voltage is detected, the DC battery circuit shall be switched off by means of a contactor fitted inside the UPS or a shunt tripped breaker.

10.9. The UPS shall employ temperature compensated battery charging to prevent over and under charging due to variation in ambient temperature.

10.10. The UPS shall maintain output stability for input voltage variation of +20% to -20% without discharging the batteries.

10.11. Batteries shall be of the low maintenance or maintenance free type with a 5 to 10-year life cycle at 20°C (specify option).

11. MICRO PROCESSOR IGBT INVERTER

11.1. The inverter shall use microprocessor and IGBT technologies to generate sinusoidal AC power.

11.2. The inverter steady-state output voltage shall not deviate by more than ± 1,5% for input voltage and load variation within the quoted limits.

11.3. The output voltage shall return to ± 2% of nominal within 20 milliseconds after a load step of 100%.

11.4. The inverter steady-state output frequency when synchronised to the standby supply shall not deviate by more than 1% or with a capture range of ± 2%, ± 3% or 6% adjustable.

11.5. The inverter shall provide harmonic filtering and neutralising to limit the THD on the output voltage to less than 3% with a linear load. For a non-linear load with a crest factor (Vp/Vrms) of 3:1 the THD shall be limited to less than 5%.

11.6. The sizing of the inverter neutral shall be a minimum of 1,7 times of the line cable in order to be able to cope with harmonics when driving single-phase loads.

11.7. A dry type isolation transformer shall be provided for the inverter AC output. The insulation shall be class H and the temperature limit of the insulation class shall not be exceeded when operated at full load within ambient temperature limits.

11.8. If an overload occurs on the output the inverter shall be capable of supplying the critical load for the following overload parameters:

- 125% overload for 10 minutes
- 150% overload for 10 seconds

- 1000% overload for 1 cycle

11.9. If an internal failure occurs in the inverter, the electronic control shall instantaneously remove the critical load and transfer to by-pass.

11.10. The inverter shall guarantee the symmetry of the output voltages at ± 1% for balanced loads and ± 3% for 100% unbalanced loads.

11.11. The phase angle displacements between the 3 phase voltages shall be:

- 120 Degrees ± 1 degree for balanced loads
- 120 Degrees ± 3 degrees for 100% unbalanced loads.

11.12. Harmonic filters shall be available if required to further reduce the THDI.

11.13. The inverter shall operate at a high efficiency to prevent excessive heat dissipation. Tenderers shall state the inverter efficiency for 25%, 50%, 75% and 100% loads. The efficiency shall be subjected to certification at the time of factory testing but shall not be less than 92 percent at the full rated load and unity power factor.

11.14. The inverter shall be short circuit proof on the output side to prevent damage to the unit.

12. ELECTRONIC STATIC BYPASS SWITCH

12.1. The electronic static switch shall be rated for continuous duty operation. Each AC phase of the input shall be individually fused with fast acting fuses.

12.2. An uninterrupted transfer to the bypass circuit shall automatically take place under the following conditions.

- Output falls outside specified limits
- Load current exceeds overload rating of UPS
- DC voltage out of limits
- Inverter failure
- Over temperature develops within inverter

12.3. Uninterrupted automatic retransfer from bypass to inverter shall be initiated whenever the inverter is capable of assuming the load within specified limits.

12.4. Uninterrupted automatic transfer and re-transfer shall be inhibited under the following conditions:

- UPS overload
- Failure of the inverter static switch
- Transfer to bypass via the maintenance bypass switch.
- Voltage of inverter or supply out of limits.
- Frequency synchronization out of limits.
- Transfer time

12.5. The no break transfer time to standby and vice versa shall be less than 500 microseconds when synchronised.

12.6. The system shall be stable and operating normally before permitting transfer of the load back to the inverter.

12.7. The transfer time when out of synchronisation shall not be more than 20 milliseconds to prevent damage to the load by phase reversal.

12.8. The overload capacity of the static switch shall be as follows:

- 150% overload - 10 minutes
- 200% overload - 1 minute
- 1000% overload - 10 milliseconds

13. MAINTENANCE BYPASS SWITCH

13.1. The UPS shall be isolated by means of a maintenance bypass switch should it be necessary to carry out normal service or repairs. No interruption in power to the critical load shall be allowed when switched to bypass or back to inverter.

13.2. Means for testing the UPS operation without affecting or disconnecting the critical load shall be provided.

14. CONTROL AND INDICATOR PANEL

14.1. A clearly laid out control and indicator panel shall be provided consisting of the following:

a. Synoptic diagram of the UPS, representing the operational status with integrated LED's and power flow indicators.
b. LOAD OFF (Emergency shut down) with protective cover.
c. SERVICE CHECK (LED), turns on when maintenance is due.
d. COMMON ALARM, visual (LED) and audible signal (Buzzer).
e. STOP OPERATION (LED), visual and audible signal approximately minutes before complete and automatic load disconnection (Over temperature or when the battery is discharging).
f. ACTIVE UPS indicator (Number displayed shows which module of a parallel system is active).
g. LOAD LEVEL and BATTERY CHARGING status indicator bars.
h. Monitoring system with LCD display menu.
i. Push buttons and indications for INVERTER ON, INVERTER OFF, MUTE and LAMP TEST.

15. REMOTE ALARMS AND CONTROLS

15.1. The UPS shall be equipped with a minimum of two D-type connectors and therefore two serial ports RS232C. The connectors shall provide the normal RXD, TXD, DTR, DSR, RTS and CTS.

15.2. The second connector shall provide interfacing by means of potential free contacts between the UPS and a personal computer.

15.2.1. The signals which should be monitored are UPS – normal operation, load on inverter, load is on bypass, interruption in mains supply.

15.2.2. Battery low/under voltage.

15.3. Remote alarm Unit (optional)

The UPS shall have a facility to display remotely, alarms and functions.

The following signals should be obtainable:

- System normal signal
- Inverter fail signal

- Standby supply to load signal
- Main supply failure signal
- Shut down imminent signal

15.4. Emergency power off remote command shall be available to shut down the Inverter and static switch.

16. INPUT HARMONIC FILTERS

16.1. Input harmonic filters shall be available if necessary to limit the total harmonic distortion at the input to less than 5% and improve the power factor to 0,83 or better at full rated UPS load.

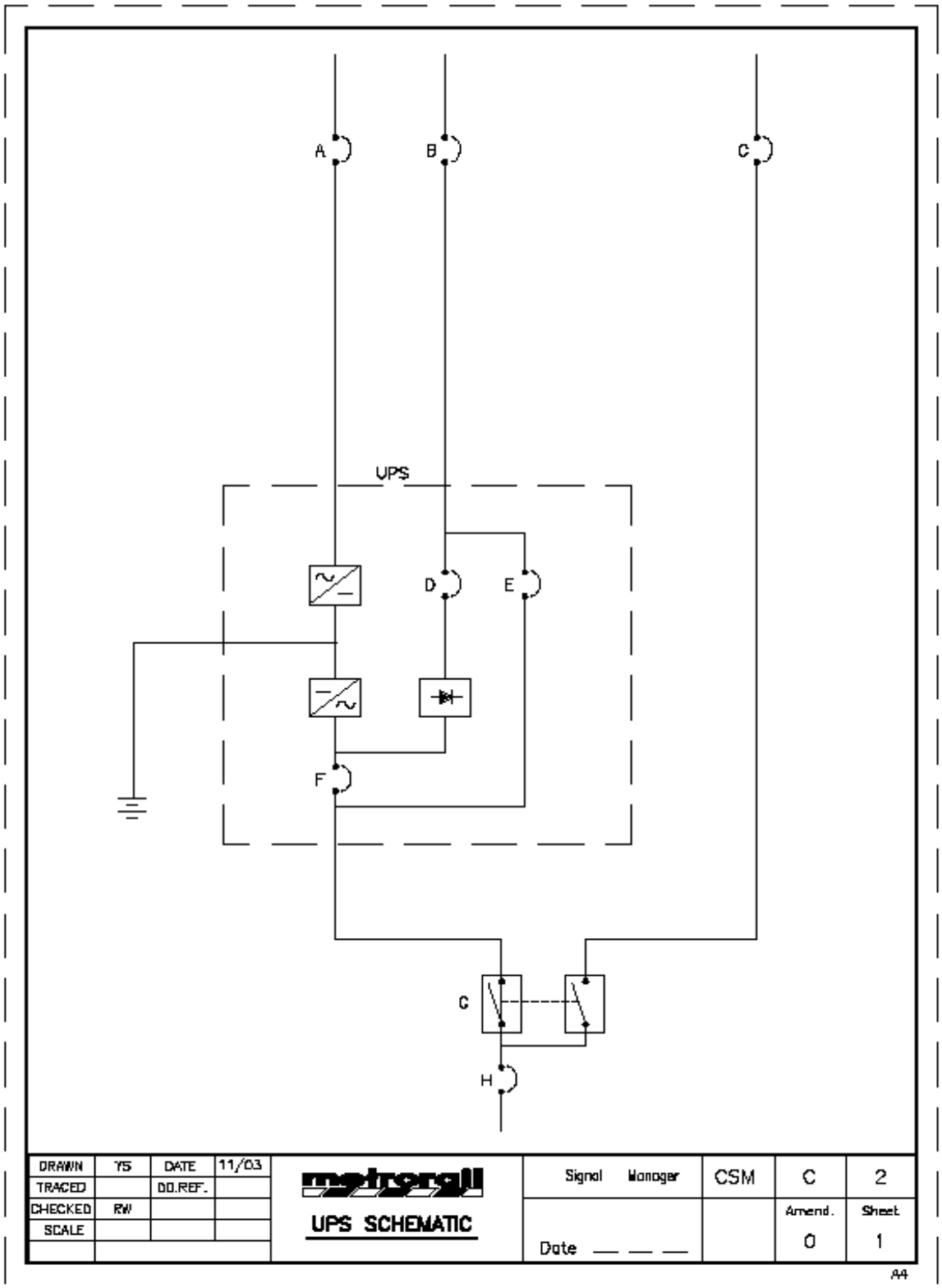
17. MECHANICAL SPECIFICATION

17.1. The UPS shall be housed in a freestanding modular enclosure with removable panels and protection rating IP22 as standard.

17.2. Forced cooling shall be provided to ensure that all components are operated within specification with air entry in the base and exit at the top.

17.3. Cable entry shall be from the bottom or top of cabinet.

- END OF SPECIFICATION -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Addendum to Specification

Railway Engineering

Characteristics of the Quality of the 230V AC Power Supply at various railway track side Installations

1. INTRODUCTION

1.1. The following is a typical representation of the power supply expected in the vicinity of a traction power line. These characteristics are to be taken into consideration when purchasing power equipment (such as UPS, chargers etc.) for Spoornet's industrial applications.

1.2. The data used in these guidelines was extracted from the findings of a Quality of power supply investigation on the 230V supply at Elands Bay – Loop 2 on the 50KV AC Orex line.

2. THE UNINTERRUPTIBLE POWER SUPPLY

2.1. The power equipment shall not be adversely affected by odd voltage harmonics between the 3^{rd} and 13^{th} harmonics of which can reach amplitudes as indicated in the following table. The THD can reach maximum amplitudes up to 27%.

2.2. The Power equipment shall not be subject to degradation when exposed to the voltage Dips with deviations to the magnitudes of –50 % on all the phases.

3. TYPICAL VOLTAGE HARMONICS ON THE 230V SUPPLY

Harmonic and THD	Highest Daily Values (%)
3rd	12
5th	9
7th	8
11th	14
13th	4
THD	27

Table 1: Typical Daily Values of Harmonics

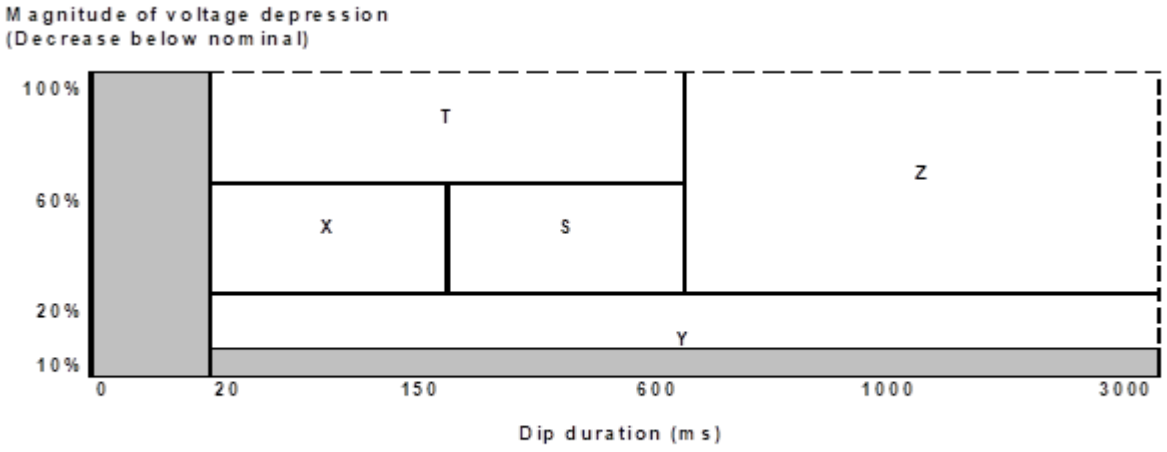
4. TYPICAL VOLTAGE DIPS ON THE 230V SUPPLY

Time	NRS048	Phases	Duration	Deviation (%)
25:51.0	X	ABC	0.040s	-28.6
59:54.0	X	ABC	0.020s	-22.6
59:54.0	X	ABC	0.030s	-22.6
59:54.0	X	ABC	0.030s	-25
59:54.0	X	ABC	0.030s	-27
59:54.0	X	ABC	0.020s	-25.6
22:00.0	X	ABC	0.070s	-15.3
59:54.0	X	ABC	0.020s	-30.8
59:54.0	X	ABC	0.030s	-28.6
59:54.0	X	ABC	0.030s	-32.5
22:00.0	X	ABC	0.030s	-15.3
59:54.0	X	ABC	0.030s	-33.6
59:54.0	X	ABC	0.020s	-32.2
59:54.0	X	ABC	0.020s	-34.4
22:00.0	X	ABC	0.110s	-15.3
59:54.0	X	ABC	0.020s	-34.9
59:54.0	X	ABC	0.020s	-36.5
59:54.0	X	ABC	0.030s	-39.5
59:54.0	X	ABC	0.030s	-39
22:01.0	X	ABC	0.110s	-15.4
59:54.0	X	ABC	0.020s	-39
59.54.3	X	ABC	0.060s	-41.8
22:07.0	X	ABC	0.380s	-16.4

Table 2: Voltage dips

5. VOLTAGE DIP WINDOW

5.1. The table below is the typical Voltage Dip Window for the classification of Dips taken from the Quality of Supply standards NRS 048-2.



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SPECIFICATION

FOR

LOW MAINTENANCE, SEALED STANDBY BATTERIES FOR RAILWAY SIGNALLING APPLICATIONS

1. SCOPE

1.1. This specification describes the requirement for semi- sealed, low maintenance standby batteries for Railway Signaling applications.

2. SERVICE CONDITIONS

The batteries shall operate within the limits laid down in this specification and shall be capable of withstanding a combination of the following environmental conditions:

2.1. Operating temperature – minus 20ºC to 60ºC with optimum operation at 25°C.

2.2. Atmosphere - Corrosive and dusty

3. REQUIREMENTS

3.1. General

3.1.1. Batteries shall be of the AGM or lead calcium type and not Gel technology.

3.1.2. The battery shall be a 10-year design life type.

3.1.3. The battery shall have a good cycling capability.

3.1.4. The battery shall have a safety valve with a flash arrestor.

3.1.5. Batteries shall be 12V blocks and not 6V.

3.1.6. In an enclosed environment where the charging equipment or Ups is in the same room, AGM type batteries shall be installed.

3.1.7. In a well-ventilated room where the charging equipment is installed in a separate room, semi-sealed, ventilated lead calcium batteries may be used.

3.1.8. After installation and charging a full load capacity test shall be done on the full battery bank and a cell by cell discharge report shall be generated for submission to Metrorail. The discharge report shall include cell voltages, total current drawn and total discharge time.

3.2. Standards:

The batteries shall comply with the following standards:

3.2.1. BS 6290 Part 4 British and /or IEC 896-2 European

3.2.2. ISO 9001

3.2.3. ISO 14001

3.2.4. IEC 707

3.3. Float voltage

3.3.1. Float voltage shall be 2.23 to 2.27 volts per cell +/- 1%.

3.3.2. The battery must be able to float throughout its lifetime without the need for equalization charges.

3.4. Battery capacity

3.4.1. The battery shall be able to perform 100% duty on the first discharge.

3.4.2. The battery shall be able to perform 100% duty after 5 years of service.

3.4.3. Batteries shall be rated for a 2-hour standby period at full load capacity with a shutdown voltage of 1.75V per cell.

3.5. Connectors and Terminals

3.5.1. All exposed terminals and connectors shall be adequately insulated while allowing for a voltage probe for measurements

3.5.2. Positive and negative terminals shall be marked, and colour coded. (Positive – Red, Negative – Blue/Black)

3.5.3. The positive and negative connecting cables from the Ups or charging unit shall be exactly the same length.

3.5.4. The positive and negative cable shall be double insulated welding cable with a minimum thickness of 16mm2.

3.5.5. During installation no oxide grease shall be applied to each terminal.

3.5.6. All terminal connections shall be torqued to the manufacturer's specifications.

3.6. Recharge Time

3.6.1. The battery must achieve 100% capacity at float voltage at maximum specified current within 10 hours.

4. BATTERY DATA

	Yes	NO		Comment
Battery Brand Name				
Manufacturer				
Country of manufacture				
Model name of Battery				
Amp Hour of Battery @ the 10hr rate to 1.80V/C @ 25ºC				
Watts per cell at time specified to 1.70V/C @ 20ºC				
Weight of individual Block (kg)				
Recommended float V/C				
Maximum equalisation V/C				
Maximum allowable charge current				
Table or graph showing Temperature versus Float voltage				

5. DOCUMENT CHECK LIST

	Yes	NO		Comment
Battery watt Table at 1.75 volts per cell at 20ºC				
Battery compliance to international standards (copies or covering letter from battery manufactures comply to international standards)				
Battery calculation sheet completed				
Detailed Maintenance plan submittal				
Temperature compensated table or graph showing Temperature versus float voltage				
Letters of compliance to standards				