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Introduction

This specification covers Eskom Generation requirements for Uninterruptible Power Supply equipment for all critical loads required for the safe running of all Generation Power Stations.

1. Scope

1.1 Purpose

The primary function of the uninterruptible power supply (UPS) covered by this specification is to ensure uninterrupted alternating power source for a specified period to critical loads. The uninterruptible power supply may also serve to improve the quality of the power supply.

Notes to *Contractor*

1.2 Applicability

Applicable to all Generation Power Stations

2. References

The following document(s) contain(s) provisions that, through reference in the text, constitute requirements of this document. At the time of publication, the edition(s) indicated were (was) valid. These documents are subject to revision and users are responsible to ensure that the most recent edition(s) of the document(s) listed below are used/referenced.

References to the following document(s) will enhance the understanding of the reader on the subject covered in this document. The requirements of these document(s) are, however, not an extension of this document.

The following performance standards were sources of information used in the compilation of this performance specification.

ESKACAAD0 – Specification for continuous analogue indicating instruments for Electrical quantities.

OPS 2365 – Specification for corrosion protection of Electrical equipment.

36-182 Rev 0	(GGM 0835 rev 0) DC Earth Fault
36-269 Rev 0	(GGP 0764 rev 1) Procedure for Maintenance of DC Systems
36-400 Rev 0	Standard philosophy of requirements for Station Control as well as power station interfaces to network service providers and network control centres
36-716 Rev 0	Eskom Generation Protection Philosophy for Large Fossil Fuel Power Stations with Generator Circuit Breakers
36-717 Rev 0	Eskom Generation Protection Philosophy for Large Fossil Fuel Power Stations without Generator Circuit Breakers
36-721 Rev 0	Generation MV and LV Philosophy for Eskom Power Stations
36-724 Rev 0	(GGS 0836 rev 1) DC Definitions
36-726 Rev 1	List of Approved Electronic Devices to be used on Eskom Power Stations
36-797 Rev 0	(GGS 0456 rev 4) Specification for switchboards and associated equipment for voltages up to and including AC 1000 V and DC 1500 V
36-813 Rev 0	(GGSS 0829 rev 2) Lead Acid Batteries

36-815 Rev 0	Specification for Battery Chargers
36-698 Rev 0	(GGS 0462 rev 1) Quality requirements for Engineering and Construction works in Generation
36-848 Rev 0	GGSS 1000 rev 1 Specification for Battery Stands at Power Stations
36-811 Rev 0	Stationary Vented Nickel Cadmium Batteries for Power Stations
36-812 Rev 0	DC to DC converter
36-813 Rev 0	(GGSS 0829 rev 2) Stationary Vented Lead Acid Batteries
36-965 Rev 0	(GGP 043 rev1) Acceptance and Commissioning of DC Supply equipment for Generation
36-958 Rev 0	(GGG 0838 rev 2) Design Guide for Power Station Battery Rooms
BS 162	Electric power switchgear and associated apparatus
BS 171	Power transformers
CISPR 16-1-1:2003	Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring *apparatus*
CISPR 16-1-2:2003	Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus - Ancillary equipment – Conducted disturbances
CISPR 22:2005	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
IEC 60050-161:1990	International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility
IEC 61000-2-2:2002	Electromagnetic compatibility (EMC) – Part 2-2: Environment –Compatibility levels for low-frequency conducted disturbances and signalling in public low voltage *power supply systems*
IEC 61000-3-2:2000	Electromagnetic compatibility (EMC) – Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
IEC 61000-4-1:2000	Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques - Overview of IEC 61000-4 series
IEC 61000-4-2:1995	Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test
IEC 61000-4-3:2002	Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4:2004	Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
IEC 61000-4-5:1995	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
IEC 61000-4-6:2003	Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields
IEC 61000-4-8:1993	Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test
IEC 61249-2	Base material for printed circuit boards part 2
SANS 10108	Code of Practice for the Classification of Hazardous Locations and the selection of Apparatus for use in such areas – Latest Revision

SANS 1091:2004	National colour standards for paint
SANS 1274: 2005	Coatings applied by the powder-coating process
SANS 1507-1:2007	Electric cables with extruded solid dielectric insulation for fixed installations (300/500V 1900/3300V) Part 1: General
SANS 1574	Electric flexible cores, cords and cables with solid extruded dielectric insulation
SANS 1632-2 2005	Batteries – Part 2: Vented type Stationary lead-cid cells and batteries
SANS 1632-3 2005	Batteries – Part 3: Vented-type prismatic nickel-cadmium cells and batteries
SANS 1652: 2004	Battery Chargers - Industrial Type
SANS 60146-1-1:1991	Semiconductor convertors; General requirements and line commutated convertors Part 1-1: Specifications of basic requirements
SANS 60146-1-2:1991	Semiconductor convertors; General requirements and line commutated convertors Part 1-2: Application guide
SANS 60146-1-1:1991	Semiconductor convertors; General requirements and line commutated convertors Part 1-3: Transformers and reactors
SANS 60269	Low voltage fuses.
SANS 60529:2001	Degree of protection provided by enclosures. (IP Code)
SANS 60947-2:2009	Low-voltage switchgear and controlgear Part 2: Circuit-breakers
SANS 60947-3:2009	Low-voltage switchgear and controlgear Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
SANS 60947-4-1:2004	Low-voltage switchgear and controlgear Part 4-1: Contactors and motor-starters - Electromechanical contactors and motor-starters
SANS 62040-1: 2008	Uninterruptible power systems (UPS)Part 1: General and safety requirements for UPS
SANS 62040-2: 2007	Uninterruptible power systems (UPS)Part 2: Electromagnetic compatibility (EMC) requirements
SANS 62040-3: 1999	Uninterruptible power systems (UPS)Part 3: Method of specifying the performance and test requirements

3. Definitions and abbreviations

36-724 (GGS0836) - Definitions of Terms Applicable to DC Emergency Supplies

4. General requirements

4.1 380V AC supply

The 380V AC supply has a preferred and alternative supply. The preferred supply is derived from

Unit # 380V Unit Brd. #A & #B on a dedicated circuit breaker and the alternative supply (Static By-pass) is derived from Unit # 380V Essential Supply / Diesel Gen Board / Emergency Supply Board on a dedicated circuit breaker.

4.2 Delivery and off-loading

UPS's are classified as equipment of delicate nature and therefore delivery is by road transport only. All stationary vented Lead acid batteries which will be used as the DC backup will be delivered dry to site. All stationary vented Nickel Cadmium batteries will be delivered in a filled state

4.3 External cabling

The *UPS supplier* provides all calculations, type and cable size of the cable between AC mains supply and UPS to the Generation *Project Manager* for approval.

All cables will be flame retardant type cables to the latest Eskom specifications.

Note: *All cables and cabling to be in accordance with Eskom's latest Standards.*

4.4 Erection

The *Contractor* is responsible for the erection and installation of the batteries, battery stands, UPS and AC distribution panel.

The *Contractor* erects the battery stands, batteries, inter-cell connectors, inter-row connectors and battery cable terminating devices in accordance with the Eskom's requirements.

4.5 Commissioning and tests on site

Commissioning and testing are carried out in accordance with 36-965 and the battery manufacturer's commissioning specification.

The *Contractor* commission and perform specified tests after installation is completed. Filling of lead acid battery cells with electrolyte only takes place after installation but prior commissioning.

Initial charging and density correction is done in accordance with 36-965 and the battery manufacturer's commissioning specification. .

After initial charging, a discharge test is performed by the *Contractor*. This test is performed in accordance with 36-965 and the battery manufacturer's commissioning specification.

Routine maintenance is performed for a period of three (3) months after energising and in accordance with 36-965.

The UPS supplier provides a competent representative on a 24 hour basis for UPS faults and is on site within 8 hours of being notified.

4.6 Miscellaneous

4.6.1 Spares and tools

The number of spares for control units, supervisory circuits, relays, electronic components, auxiliary fuses, are limited to as few different types as possible.

Any keys and special tools required for maintenance are supplied with the equipment and are contained within the cubicle.

The UPS supplier submits an itemised spares list that is recommended for maintenance purposes for each UPS. The spares list states the price of each item.

4.6.2 Drawings

The following drawings are provided with the *tender*:

- Typical cross-sectional drawings showing compartments, bus bars, UPS's, cable terminations etc.
- General arrangement drawings of the system. The height of cable glands above the floor level is marked as well as relative positions of cable slots.

The following drawings are provided in accordance with the programme:

- schematic and wiring diagrams.
- schematic and wiring diagram for control cards, alarm cards, relay cards etc

- circuit diagram for each unit, sub-unit and plug-in board.
  - component/part list for each unit, sub-unit and plug-in board used stating manufacturer, type and rating of each component.
  - component layout drawings for each unit, sub-unit and plug-in board used.
  - servicing diagrams for maintenance purposes shall show all individual components and their interconnections and aids for rapid fault finding.
- internal wiring diagram of each type of relay used.
- general arrangement drawings of cable terminations.

A complete set of discharge characteristics, plotted on axes of cell voltages and time for the following rates of discharge:

a) 10h, 9h, 8h, 7h, 6h, 5h, 4h, 3h, 2h, 1h, 0.75h, 0.5h and 0.25h

b) for each of these discharge curves the following data is given:

1) magnitude of the constant discharge current in amperes
2) the "initial" voltage per cell
3) the "final" voltage per cell

A set of recharge curves that show percentage charge and relative density plotted against time applicable to the particular cell when used under the following conditions:

a. the stated nominal voltage levels for float and equalise operation are applicable to constant voltage charging

b. 60% of the stated charger rated current output is available during constant current charging in the float mode

c. the stated maximum equalising current is available during constant current charging in the equalising mode

d. The battery has been completely discharged at the 10h rate prior to commencement of recharge.

4.6.3 Training

It is the responsibility of the *UPS supplier* to provide adequate training to Eskom Generation personnel in the operation and maintenance of the Plant supplied. The number of *Employer's* personnel requiring training is specified in Schedule A.

4.6.4 Instruction (Operating and Maintenance) Manuals

The number of copies is as specified in Schedule A. The manuals are complete with:

- power station name and order number
- index
- list of reference drawings
- details of all components

The manuals to be submitted must be in electronic format and in loose-leaf binders to ISO format and normally A4 size. The use of oversize pages is kept to a minimum and does not exceed page height unfolded. Fixings are preferably D - ring and be of the snap close type. Post binders or other fixings are not acceptable. Binders do not exceed 80 mm in overall thickness. The document identity appears on both the front cover and on the spine.

Manuals are of good quality prepared by suitably experienced personnel and contain general arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts lists which are accompanied by exploded view type drawings clearly

detailing the part and uniquely identifying it, technical descriptions of the plant and material and component parts, spare part ordering instructions and type test certificates. Any special instructions pertaining to storage of spare parts or to their shelf life are included in the manual.

All drawings required for component location, dismantling, and re-assembly for maintenance is provided in the manual. All special tools required for maintaining and operating the plant and material are identified in a schedule and described in the manual.

DESCRIPTIONS:

NOTE: THE FOLLOWING DESCRIPTIONS INDICATE THE MINIMUM AND ARE TO BE READ IN CONJUNCTION WITH THE DETAILED TECHNICAL REQUIREMENTS

DESCRIPTION OF A HALF LOAD PARALLEL REDUNDANT SYSTEM

This configuration of equipment consists of a dual redundant system (2 units in parallel), where each unit shares the load in equal proportion, or as a single unit. Each UPS consists of all the components listed in the specification including a full Microprocessor control 12 pulse rectifier, static bypass, manual bypass and synchronized inverters. All UPS controls functions, alarms, history and data acquisition will be controlled via the Microprocessor. In the event of an inverter output failure e.g. Thyristor/IGBT failure, the faulty unit shuts down and the full load is automatically assumed by the remaining unit. There is no voltage fluctuation, frequency fluctuation or short breaks in the output voltage of the UPS system under any operating conditions whatsoever.

In a half load parallel redundant situation the configuration will consist of the following:

Two UPS units run in parallel with one another. Any one of the two units can be configured as the master or the slave system.

Each unit will run at half its maximum load capability thereby sharing the load equally, thus all components will be driven on at half their full load rating. It's important that each UPS run at less than 50% full load, because if the total load is 20A the UPS should at least be rated to carry 30A each. This is required to ensure that each UPS in parallel will be loaded to 10A and not 15A to allow capacity for transient response / step loading and extra for future load increases. Dual redundant parallel UPS units must each be rated for 20% above the total load, in order to ensure that a single UPS will not be loaded more than 80% of its capacity when supplying the total load as a single unit. If more than two UPS units are installed in parallel and one UPS unit should fail the remaining UPS units may not be loaded more than 80%.

The UPS shares the load equally under normal operation and is adequately rated to accept the full load +20% when any one unit fails without distortion of the output voltage.

> Each UPS will be fully microprocessor controlled with all related functions. All settings, control, alarming, monitoring and logging of history will be done via the microprocessor. The micro processor must be capable to store at least a 100 events on a first in fist out principle. As a minimum all the unhealthy conditions will be logged and stored as a single event log entry. A charger status change is also defined as an event.

- Each individual UPS unit must be equipped with a static and manual bypass facility.
- Should a failure occur on one of the units then the second unit automatically assumes the full load without any power interruption to the load.
- It shall be possible to disconnect and remove any of the two units or both, without disruption of the output power to the load.
- It shall also be possible to increase the UPS plant capacity in future by adding another UPS unit in parallel.

5. Tests

5.1 Applicability

The UPS is type and routine tested in the factory as a complete UPS, and less extensive operational tests with actual batteries and load are performed on site. The final test on site ensures correct connection between units, ventilation, cooperation between units, function of battery, etc. The type and routine tests are carried out in accordance with IEC 60146 Part 4 (Semiconductor converters. Part 4: Method of specifying the performance and test requirements of uninterruptible power systems). The following functional unit tests are performed and the details of the tests are given in Table 1.

Table 1

Test description	Type test.	Routine test	Test applicable to a parallel redundant UPS system	IEC 60146-4 Sub-clause.
Interconnection cable check.	√	√		7.4.1.
Light load test.	√	√		7.4.2.
Checking of auxiliary devices.	√	√		7.4.3.
Synchronisation test.	√		√	7.4.4.
AC input failure test.	√	√		7.4.5.
AC input return test.	√	√		7.4.6.
Simulation of parallel redundant UPS fault	√	√		7.4.7.
Transfer test.	√	√		7.4.8.
Full load test.	√		√	7.4.9.
UPS efficiency.	√			7.4.10.
Unbalanced load test.	√		√	7.4.11.
Output voltage unbalance.	√		√	7.4.12.
Actual load test			√	7.4.13.
Current division in parallel UPS	√	√		7.4.14.
Rated stored energy time, battery test			√	7.4.15.
Rated restored energy time.			√	7.4.16.
Battery ripple current.			√	7.4.17.
On site ventilation test.			√	7.4.18.
Overload capability test.			√	7.4.19.
Short-circuit current capability			√	7.4.20.
Short-circuit fuse test.			√	7.4.21.
Restart.			√	7.4.22.
Output over-voltage.			√	7.4.23.
Periodic output voltage modulation.				7.4.24.

Test description	Type test.	Routine test	Test applicable to a parallel redundant UPS system	IEC 60146-4 Sub-clause.
Frequency modulation.				7.4.25.
Radio frequency interference and conducted noise.				7.4.26.
Harmonic components.				7.4.27.
Audible noise.			√	7.4.28.
Earth fault test.			√	7.4.29.

5.2 Test Certificates

Three copies of all tests certificates for each UPS are submitted to the *Project Manager* not later than two weeks after the completion of the tests.

All Type test document are to be submitted with the tender documents. Type testing of all equipment to be done as per SANS or IEC standards. Test certificates by an authorized test facility must be supplied.

6. UPS Configuration and Mode of Operation

The required UPS configuration for each unit is a parallel redundant configuration with an automatic bypass and a manual maintenance bypass. In this configuration two identical UPS units are in parallel, sharing the load current. The output rating of each UPS unit is equal to the total load requirement plus 20%.

With the parallel redundant UPS configuration, the failure of a component, system, subsystem does not lead the failure of both UPS units.

The inputs to the UPS units are connected to separate input ac supplies. The output of each UPS unit is connected to a common load busbar via separate automatic switches as shown in figure 1. Each UPS unit in the parallel redundant configuration operates in an exact manner as a single configuration.

During normal operation, the load is shared equally between the UPS units. Adequate monitoring and control is provided via the microprocessor to ensure this. The output of the UPS units are synchronised with each other during normal operation.

Upon failure of a UPS unit, the failed UPS unit is automatically disconnected from the load busbar while the healthy UPS unit remains in service and provides the additional load current. Each UPS unit is therefore capable handling a step load of at least 50% of full load rating, at any point of load, from no load to 50% load. During the shutdown and disconnection of a faulty UPS unit, no disturbance outside the specified output tolerances occurs on the output busbar.

An UPS unit does not shutdown or be disconnected from the load busbar for an ac input failure or a shutdown of its rectifier.

After repairs or restoration of a disconnected faulty UPS unit, it is possible to manually initiate automatic synchronisation of this UPS unit with the other UPS unit in operation and subsequent reconnection of the UPS unit to the load busbar. Automatic reconnection of an UPS unit does not occur if the outputs are not synchronised. The process of synchronisation and reconnection occurs without disconnecting the load and without any disturbance, outside the specified tolerances, occurring on the output busbar.

During normal operation, the output is kept in synchronism with the ac input supply to which the automatic bypass is connected. If the frequency of this ac supply deviates beyond the specified output tolerance, the UPS unit reverts to the internally generated frequency. At no stage during this operation is the bypass supply connected to the load busbar.

The following conditions must be met before the UPS unit is switched to the load bus:
- The voltage frequency of the UPS unit to be synchronised to equal the load busbar frequency.
- The voltage magnitude of the UPS unit to be synchronised to equal that of the running system.
- The angular difference between the voltage vector of the UPS unit to be synchronised and the running system to be smaller than 5°.
- The phase rotation of the UPS unit to be synchronised and the load busbar to be the same.

The process of obtaining the above conditions is performed automatically by a synchroniser relay. The synchroniser relay not only senses when the correct conditions have been met but also produce correction signals to operate devices in the voltage regulating systems of the inverter.

The synchroniser relay must be designed as a two-channel circuit with monitoring functions between the two channels. A synchronising signal for synchronisation, is only issued by the relay if both channels give permission for synchronisation. The monitoring function between the two channels will block the output functions of the relay when it detects a fault in any one of the channels. The installed synchroniser relay must be equipped with a recording function, which shall be activated with every synchronisation. The recording function will include all three phase analogue voltage values and synchronising pulse activation. Two three phase synchroniser relays shall be installed per unit.

TYPICAL SETTINGS
- Δ f/Hz (Slip) = 0,1Hz
- Maximum difference in voltage magnitude = <5% of nominal (Preferable =<2V)
- Maximum difference in voltage phase angle = ±5° (Preferable < ±2,5°)

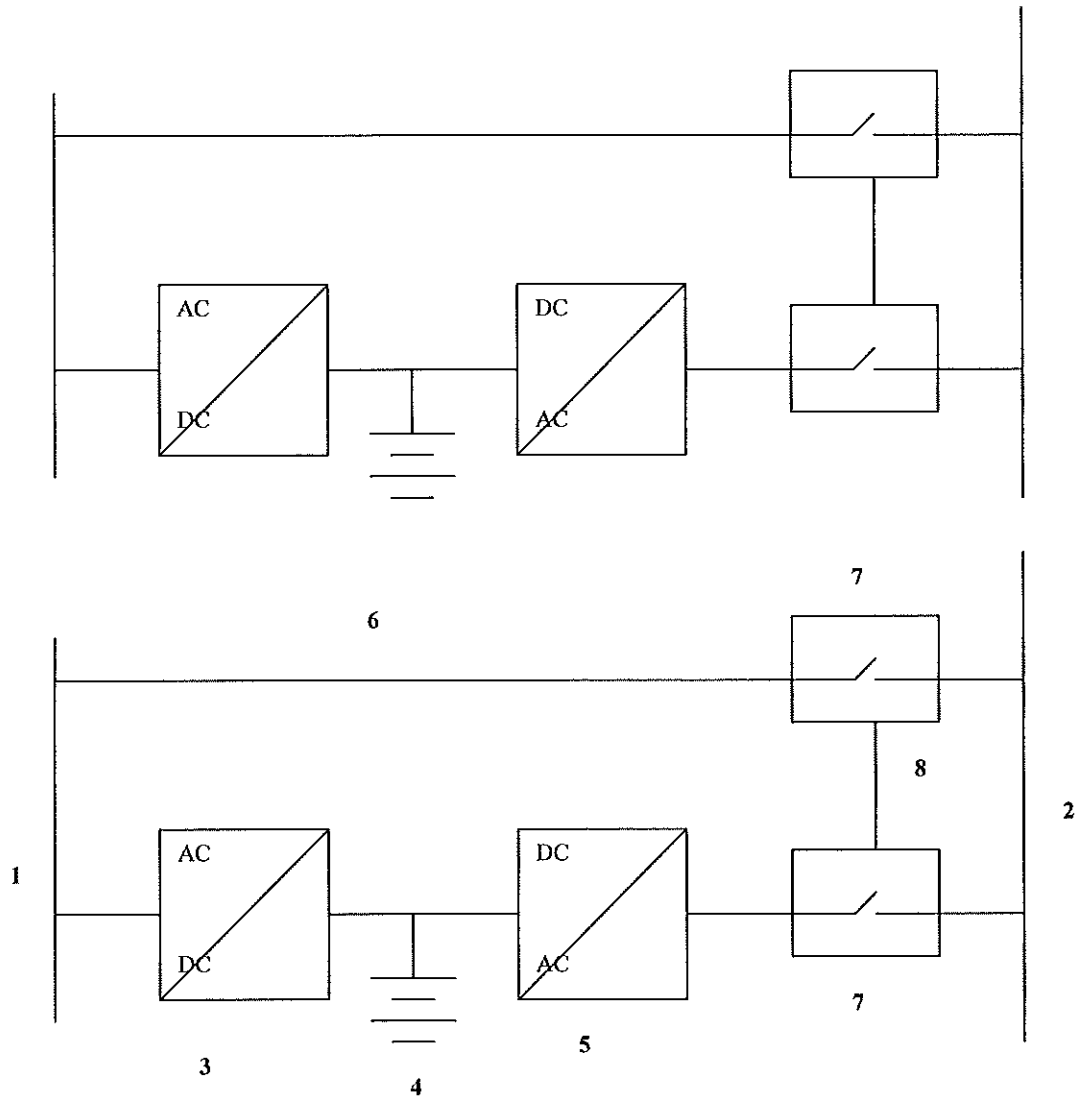

FIGURE 1

1. Mains supply
2. Load feeder.
3. Rectifier.
4. Battery.
5. Inverter.
6. Bypass supply
7. Static bypass switch and 8: Interlock.

Transfer of the load to automatic bypass supply occurs under the following abnormal conditions, assuming the quality of the raw ac supply is within the tolerances specified for the load:

- Output failure of both units.
- Where loads require high in-rush currents or starting currents on switching, the automatic bypass supplies the load for the duration of these peak currents. Supply will revert to UPS power when the load current is within the rating of the UPS. Loads that require automatic bypass are detailed in Schedule A so that the automatic bypass is sized accordingly.

6.1 Maintenance Bypass and Automatic Bypass

The load is first transferred from the UPS configuration to the automatic bypass. Since both automatic and maintenance bypasses are fed from the same supply. The manual maintenance bypass may be closed, putting the bypasses in parallel. The automatic bypass will then be disconnected from the load. When the load is to be transferred back to UPS configuration, the exact reverse of the above operation is done. Only when the maintenance bypass is opened, is the transfer done from bypass to UPS configuration. The UPS configuration and maintenance are never to be connected to the load at the same time and a break in supply to the load should never occur.

The transfer control provides the following features:

- Transfer of load from UPS configuration to the bypass and vice versa takes place without any interruption of supply to the load and without any disturbance beyond the specified tolerances occurring on the load busbar.
- During synchronisation or loss of synchronisation, the rate of change of frequency (slew rate) is controlled so that the load is not disturbed.
- Retransfer of the load from the bypass back to the UPS configuration is automatic, if the fault was temporary.
- Automatic retransfer is inhibited if the first attempt at retransfer was unsuccessful
- It possible to manually initiate an automatic transfer of load from UPS configuration to the bypass and vice versa.

6.2 Automatic Bypass and UPS Output Switches

The automatic bypass switch and the UPS output switches operate as specified in 14.2.1.

These switches are suitably rated to carry full load current as well as inrush currents. The switches are of the hybrid type. The hybrid type is a combination of a static and an electromechanical switch. The static type is used for the initial part of the closing action and carries current until the electromechanical part has closed and taken the load.

The static part of the hybrid switch is rated to continuously carry the full load current for the duration the electromechanical switch takes to close.

6.3 UPS Sub-systems

6.3.1 General

a) Modularity

The design and construction of all UPS functional units are modular as far as possible.

b) Suitability

All semiconductor devices, power transformers, chokes and other components forming part of the UPS equipment are suitable for the particular application with respect to their rated voltages, rated current, temperature rise and service life.

c) Power Terminals (AC and DC)

Terminals for external cabling above 16mm^2 are of the stud type complete with bolts, nuts, washers and locking devices. Two terminal studs are provided for each "way", and are of sufficient length to accommodate two ring tongue terminations in addition to a full nut and a locking device.

Terminals used for the supply of power to the automatic and manual bypass are rated for the full load of the UPS configuration.

Barriers are provided between terminal "ways". These barriers project at least 3mm above the studs. The arrangement of stud type terminals is to be shown on drawing number #.##/#### (Cable Terminations for PVC Cables), #.##/#### (Control and relay panel wiring terminations) and #.##/#### (Power and Control Wiring Terminations) and supplied with all other design drawings and documentation. Drawing's to be supplied by the equipment Supplier.

d) Control terminals

Terminals are provided for the connection of remote alarms, protection circuits and any interlocking circuits.

The terminals are of the rail mounted screw clamp, spring-loaded insertion type where the lugs are compressed between two plates by means of a terminal screw. The terminals are shown on drawing number #.##/#### (Control and relay panel wiring terminations), #.##/#### (Cable Terminations for PVC Cables) and supplied with all other design drawings and documentation.

e) Circuit breakers

All circuit breakers are provided with auxiliary contacts for protection and alarm purposes.

f) Earthing

All exposed non-current carrying parts are earthed onto the earth bar using standard green/yellow PVC insulated earthing conductors.

g) Control equipment

The printed circuit boards used for the control and monitoring are mounted inside the cubicle, with alarm LED's, test points and essential potentiometers made accessible on each board. The control equipment is interchangeable between UPS systems of different ratings within the same range.

The control equipment is designed to operate from a maximum of 24V DC, irrespective of the output voltage of the rectifier. Power to the control equipment and instrumentation is supplied from either the following sources whichever is available:

- AC supply through a regulated power supply.
- UPS battery, through a power supply if necessary.

The above supplies are blocked from each other by means of blocking diodes.

h) Power semiconductors

No unique or deducted power semiconductors or modules are used, only standard devices available from more than one supplier are used. Cascading semiconductor devices is parallel in order to increase their capability is not acceptable.

i) Ventilation & Cooling Requirements

Each UPS unit is capable of operating in the temperature range of -10°C to +40°C at an altitude of 2000m. The ventilation required to achieve this is either forced or natural, with the following constraints:

- Removable filters are provided on all ventilation grilles to prevent dust and dirt from entering the cabinet.
- Any extraction fans provided within the UPS cabinet are of the bearing type, and the inverter cooling continues to operate when the mains, is not available and the inverter is running off

the batteries. The fans are situated in a position where air flow cannot be impeded accidentally in any way; and

- The supplier indicates the amount of free space required on all sides of the UPS system to ensure adequate ventilation of the system.
- Substantiated proof of long term life of the cooling fans.
- 100% cooling fan redundancy must be provided.
- Detection and alarming of cooling system failure and temperature inside the cabinet.
- Protection such as rectifier and inverter shut down or current reduction following early warning high and high-high temperature alarming, when the temperature inside the UPS cabinet exceeds a specified maximum value IEC standards.
- Variable speed control on the cooling fans in accordance to (variable speed drive specification).
- Cooling fans should pressurise the UPS cabinet rather than extracting air from the cabinet.
- The method of ventilation shall be sufficient to enable the UPS to continuously maintain the rated output in the specified environment conditions.
- The cooling should be sufficient to maintain the temperature inside the UPS cabinet to below the value stipulated in the relevant IEC standards. The temperature measuring position will provide a true reflection of the temperature inside the panel.
- Provision shall be made to prevent dust ingress into the cabinet.

6.3.2. Rectifier

a) General

The rectifier is used to supply dc power to the inverter and to charge batteries. The rectifier is suitable for use on an earthed, three-phase four wire supply system detailed in schedule A. A double-wound transformer is provided on the AC input to the rectifier to isolate the rectifier from the AC supply.

Provision is made for float, equalise and auto-boost of a battery bank. The rectifier operates with the inverter connected and the battery bank connected. Provision is also made for initial charge of a battery bank with the inverter disconnected.

The rectifier will be fully compliant to the Eskom specification 36-815 – Specification for battery chargers in power stations. The schedules in this specification must be completed as part of the UPS tender.

6.3.3. Inverter

a) General

The inverter produces an alternating sinusoidal voltage of constant amplitude and frequency. The nominal output voltage and frequency is stated in schedule A. The voltage, frequency and harmonic content remain within the limits specified in schedule A.

The inverter input is permanently connected to the DC link and takes its power from the rectifier or the battery bank when the rectifier is in the float and boost modes.

The inverter is not connected during initial mode of charging.

b) Frequency

The output frequency is controlled from within the inverter circuitry itself and is synchronised to the frequency of the mains and any other inverter operating in conjunction with it. Each

inverter has its own frequency controlled from within its own circuits and not from a common control circuit.

c) Output filter

The output voltage of the inverter is sinusoidal with a harmonic content within the limits specified in Schedule A.

d) Step load application

The voltage and frequency deviation from the nominal values is kept within the tolerances specified in Schedule A in response to a 100% step load application. The duration of this deviation does not exceed the maximum recovery time specified in Schedule A.

e) Overload capability

The inverter is capable of supplying load current in excess of the rated load current. The magnitude and duration of this overload current complies with the values given in Schedule A.

f) Short-circuit and current limit capability

The inverter is capable of withstanding a direct short circuit placed across its output terminals. The current limit setting complies with the values stated in Schedule A.

g) Input voltage range

The inverter is capable of supplying the rated voltage and full load current with the input DC voltage within the limits specified in Schedule A.

6.3.4 Metering, Controls, Alarms and Indications

a) Metering

A mimic display panel showing the various main components of the UPS is provided in the front panel of the UPS unit. This mimic display panel has digital indicators for panel monitoring and digital display is of the auto-ranging 3,5 digit type.

Selection of the required measurements is by means of a clearly labelled latching push-buttons as specified in Schedule A. The following selections are provided:

- Battery DC voltage
- Battery DC current
- Inverter output voltage per phase
- Inverter output current per phase
- Inverter output frequency

b) Controls

The following controls are provided on the mimic display panel:

- Alarm acknowledge
- Alarm reset
- Equalise charge
- Rectifier on/off switch; and
- Inverter on/off switch.

6.3.5 Alarms and Indications

a) General

Each UPS unit is fitted with a mimic display on the front panel of the unit. All luminous alarms are LED and are placed on the mimic panel in or around the block diagram of the UPS functional unit relating to the particular alarm. Green LED's are used to indicate operational circuits and red LED's are used to indicate non-operational circuits and/or fault conditions. An LED test facility is provided. Each LED is labelled with a suitable code, with all codes being explained with a clear description of the meaning of each alarm on a label placed beneath the mimic.

b) Individual alarms

Each UPS unit is provided with the following local and remote alarms. Any time delay is specified in Schedule A.

b1) Mains available

A green LED is used to indicate that ac mains are available within the tolerances specified in Schedule A. A red LED indicates that either the mains is unavailable or not within the voltage and frequency limits.

b2) Rectifier operation

A green LED is used to indicate that the rectifier is operating correctly and supplying power to the battery and the inverter with voltage and ripple content within the limits specified in Schedule A. A red LED is used to indicate that the rectifier is unable to supply power to the battery and the inverter for one or more of the following reasons:

- Mains failure to the rectifier
- Rectifier failure
- Rectifier voltage out of limits
- Ripple voltage out of limits
- Auto boost faulty

b3) Battery operation

The following alarms associated with the battery are provided:

Battery under-voltage is initiated when the battery voltage drops below the minimum value specified in Schedule A.

Equalise charge is initiated with the application of a equalise charge on the battery.

Auto boost charge is initiated by the application of an auto boost charge on the battery.

b4) Inverter operation

A green LED is used to indicate that the inverter is running and supplying the load with a sinusoidal voltage within the voltage and frequency limits specified in Schedule A. A red LED is used to indicate that the inverter is not supplying the load for one or more of the following reasons:

- Inverter –off, failure or stopped;
- Battery under voltage and rectifier failure;
- Voltage or frequency out of limits; and
- Inverter overload.

b5) Output indications

The following alarms indicate whether the load is being supplied within the limits specified in Schedule A, as well as the source of supply:

- Inverter output available/not available
- Automatic bypass on
- Manual bypass on
- UPS output failure
- Load supplied from both UPS's or from one unit.

b6) Remote alarms

Each UPS unit is provided with a relay dedicated to each alarm for remote indication of these alarms. Each relay is equipped with two normally open and two normally closed potential free contacts to provide for two independent sets of remote alarms.

6.3.6 UPS Protection

a) General

Electronic monitoring and shutdown of an UPS configuration or any part of it under fault conditions is preferred. Only in cases where this is not possible, are other means of protection to be used.

b) AC input protection Mains feeders

The *Employer* provides the switchgear and fuses for the power feeders to the UPS equipment. The fuses are high-breaking-capacity types, rated as stated by the *Contractor* in Schedule B.

c) Abnormal ac input conditions

The UPS equipment is capable of operating as specified with the ac input voltage variation specified in Schedule A without causing the operation of protective devices or systems that are part of the UPS. The rectifier input is however protected against over-voltage and under-voltage outside the specified range that could cause damage to it or could lead to malfunction. This is achieved by automatic and immediate shutdown of the rectifier. When the ac input returns to within the specified values, the rectifier automatically resumes normal operation.

d) AC input transients

The rectifier does not shutdown when subjected to AC input transients lasting less than 10ms.

e) Surge suppression devices

In order to limit the magnitude of transient voltage surges(including voltage spikes) due to switching and other circuit disturbances, the primary circuit of the rectifier is provided with suitable semi-conductor or resistance capacitance surge suppressors, or both.

f) Phase sequence

A circuitry is provided to prevent the rectifier from starting with an incorrect phase sequence.

6.3.7 Rectifier Protection

a) Overload protection

The rectifier automatically shuts down on a sustained overload on its output, if it is not within its specified overload capabilities. Internal device protection does not operate.

b) Output short circuit protection

The rectifier limits it's short-circuit current and shutdown if the fault is not cleared by the rectifier output protection. Internal device protection does not operate unless automatic electronic shutdown fails.

c) Internal device protection

Rectifier diodes and thyristors are protected by high-speed, HRC thyristor fuses and are selected in such a manner that the failure of a component in any one arm of the rectifier does not result in damage to any of the remaining healthy components. This protection acts in case of internal short circuits or device failure. Operation of this protection causes immediate and automatic shutdown of the rectifier.

d) Inrush current

The inrush current into the rectifier or rectifier input transformer is limited or the rectifier and all associated equipment are capable of handling the inrush current without damage or malfunction.

The procedure for returning to service clearly indicates that the initial starting up of the rectifier is done prior to closing the rectifier output isolating switch in order to prevent inrush to the battery from blowing the rectifier output fuse or damaging the smoothing capacitors.

e) Equalise charge inhibit

The rectifier does not operate in the equalise charge mode in the event of battery room ventilation failure.

f) Initial charge inhibit

The rectifier is inhibited from operating in the initial charge mode while the inverter is connected to the DC bus or battery room ventilation failure or high hydrogen measurement in battery cabinet.

g) Reverse current drain

Under rectifier fail conditions, the reverse current from the battery is limited to 0,5A and provides for protective devices, indicating instruments and alarm circuits only.

h) Rectifier ripple voltage protection

The rectifier shuts down and gives an alarm indication if the voltage ripple on the dc bus exceeds the value specified in Schedule A.

6.3.8 Battery Protection

a) **Incorrect battery termination**

A suitably rated reverse diode is provided in parallel and a suitable rated fuse in series with each capacitor bank to protect the smoothing capacitors when the battery polarity is incorrect.

b) **Battery over-voltage**

The rectifier is provided with an active form of battery over-voltage protection. The rectifier voltage level at which the rectifier shuts down is specified in Schedule A. The shutdown remains in operation until manually reset. The battery over-voltage protection does not come into operation during initial charging.

c) **Overcurrent**

The battery output terminals are provided with suitably rated fuses in order to protect the battery against over-currents of any nature. The fuses do not operate at currents below the specified maximum charging or discharging current levels.

6.3.9 Inverter Protection

a) **Overload protection**

The inverter automatically shuts down on a sustained overload on its output, if it is not within its specified overload capabilities. Internal device protection does not operate.

b) **Output short-circuit protection**

The inverter limits it's short-circuit current and shutdown if the fault is not cleared by the inverter output protection or the load protection. Internal device protection does not operate unless automatic electronic shutdown of the inverter fails.

The inverter has a surge capacity adequate to rupture the maximum load fuse size specified in Schedule A upon an external fault.

c) **Internal device protection**

Internal switching devices or elements (thyristors, transistors, etc) are protected by high speed HRC fuses and are selected in such a manner that the failure of any component does not result in damage to any remaining healthy components.

This protection operates in case of internal short-circuits or component failure. Operation of this protection causes immediate and automatic shutdown.

d) **Abnormal input dc voltage**

The inverter automatically shuts down when the input dc voltage deviates beyond the specified minimum or maximum levels. When the DC voltage returns to within the specified normal range, the inverter starts automatically.

e) **Abnormal ac output voltage**

Circuitry is provided to continuously monitor the inverter ac output voltage. When this voltage deviates beyond the specified tolerances, the inverter automatically shuts down or is disconnected from the load busbar.

f) **Inrush current**

The inrush current into the inverter is limited or the inverter and all associated components are capable of handling the inrush current without damage or malfunction.

g) **Automatic switch protection**

The automatic switches used for the connection of the UPS units to the load busbar and for the automatic bypass are protected against short circuit currents.

Where semi-conductor devices are used as part of switches, they are protected by high speed HRC fuses. These switches are protected against exceeding the specified overload rating. This is done by automatic electronic shutdown or by fuses.

6.3.10 UPS Isolation

a) **Input isolation**

The input to every UPS unit and static bypass is provided with a disconnecting switch. By opening such a switch, the input to that UPS unit or bypass is completely isolated from any other UPS unit or bypass input and from the ac input source. These disconnecting switches do not form part of any other protection system or equipment specified.

b) **Output isolation**

The output of every UPS unit and static bypass is provided with a disconnecting switch. This disconnecting switch completely isolates the output from every other output and from any common busbar or connecting point. These disconnecting switches do not form part of any other protection system or equipment specified.

c) **Battery isolation**

The battery is provided with a disconnecting switch that isolates the battery from the DC bus. After isolating the battery with a disconnecting switch, it is possible to operate the rectifier and inverter to supply the required load.

d) **Disconnecting switches for isolation (Distribution board)**

For a single phase circuit, the disconnecting switch, disconnects the phase conductor of the circuit. For a three phase circuit, the disconnecting switch, simultaneously disconnects all phase conductors of the circuit.

These disconnecting switches are either fused isolators or moulded case circuit-breakers as specified in Schedule A.

e) **Auxiliary circuit protection**

The auxiliary circuits that are fed from the main distribution board must be suitably protected as per 36-797 Rev 0, (GGS 0456 rev 4) Specification for switchboards and associated equipment for voltages up to and including AC 1000 V and DC 1500 V.

f) **Control failure protection**

A UPS unit or UPS functional unit shuts down immediately and safely when failure of a related control circuit or of the power supply or feedback to such a circuit.

Rectifier failures do not prevent the inverter from supplying power to the load, from the battery. Inverter failures do not prevent the rectifier from charging the battery.

(g) Protection of internal wiring

Devices used for overload and short-circuit protection of components or functional units or circuits may also provide protection for the associated wiring.

6.3.11 Hardwire Protection

The following minimum hard wire protection must be included as an integral part of the UPS:

- Over voltage protection on rectifier output
- Over voltage protection on load
- Over temperature monitoring

6.4 General Capabilities and Characteristics of The UPS System

6.4.1 Efficiency

The total efficiency of the UPS system is stated by the *Contractor* in Schedule B. This figure is calculated for 100%, 50% and 25% output load. It takes into account the total input power including power to auxiliaries and controls.

The figures are given for two cases, namely, with the battery fully charged and floating on the dc bus and for the battery fully discharged and being charged at its normal charging rate.

6.4.2 Audible noise

The maximum level of audible noise generated by the UPS system is specified in Schedule A. This value is measured at any point at a distance of 1m from the UPS system cubicle with the UPS operating at full load.

6.4.3 RF interference

The equipment does not exceed the RF interference limit published in the Government Gazette R2247, dated November 1974 or latest amendment.

6.4.5 AC input supplies

The AC supplies characteristics are detailed in Schedule A.

6.5 Cubicle Contruction Requirements

6.5.1 Cubicle construction

The UPS is housed in a cubicle, having a degree of protection IP 31 to IEC 60529. The cubicle is designed so that no dust or other foreign particles can enter the cubicle from above. Only the cubicle doors leading to supply fuse and control cards are lockable and access to all components is from the front. The remainder of the cubicle covers are bolted, with warning signs attached.

An undrilled removable, unpainted, corrosion resistant, metal gland plate is provided for bottom cable entry.

6.5.2 Cubicle finish

After fabrication is complete, the metal surface is finished either in baked enamel, or powder coated in accordance with SANS 1274. The finish is corrosion resistant for interior use, in accordance with the requirements specified in Schedule A. Both the interior and exterior are light grey, number G29, in accordance with SANS 1091 with a minimum paint thickness of 50 microns.

6.5.3 Earthing

Each battery cubicle is provided with a 25mm x 3mm copper earth bar within the cubicle with suitable arrangements for connection of the main external earth.

All exposed, non-current carrying metal parts are earthed on the earth bar using standard green/yellow PVC insulated earthing conductors of sufficient cross-section.

6.5.4 Minimum clearances

The pole-to-pole and pole-to-earth clearances are not less than 10mm. The terminals for connecting battery are separated from each other by at least 250mm and are completely shrouded.

6.5.5 Instruction manual holder/circuit diagram

A simple method is provided for holding a copy of the equipment instruction manual inside the cubicle, preferably on the inside of the door. Means are provided for fixing a specially prepared durable material copy of the circuit diagram of the battery charger in an approved position within the cubicle.

6.5.6 Light emitting diodes

All LED's are subject to the *Employer's* approval, and are of a type that is readily available. LED's are mounted in suitable holders or on properly fixed printed circuit boards. Either method of mounting provides screwed terminals to accept wire of maximum 1.5mm^2 cross section. A test facility is provided to test LED's. Alarm indications remain until they are reset, even if the alarm initiating condition disappears.

6.5.7 Printed circuit boards

Maximum use is made of plug-in printed circuit boards for UPS cards. Printed circuit boards comply with the following requirements:

- Printed circuit boards use an epoxy woven glass fabric copper-clad laminate sheet in accordance with IEC 61249-2-5
- Printed circuit boards are of a thickness, which is commensurate with the weight of the components, mounted on them. The minimum thickness is 1,5mm.
- For plug-in cards all sockets, plugs and edge connectors are hard gold plated. Plating specifications shall be made available to the *Employer* on request.
- Plug-in connectors are provided with at least two parallel paths per way.
- Track is always sufficient to ensure a negligible temperature rise at the design current.
- Each plug-in card is polarized mechanically to prevent a card being inserted the wrong way.
- Printed circuit boards are provided with rigid and positive support.
- All static-sensitive boards are provided with suitable warning labels.
- Where static-sensitive boards are used, an earth connection socket is provided for the connection of an anti-static wrist strap.

6.5.8 Moulded case circuit breakers

Moulded case circuit breakers comply with IEC 60947-2.

All load circuit breakers are provided with auxiliary contacts for alarm purposes. Circuit breakers are mounted inside the cubicle. The AC incoming supply to each UPS is controlled by a moulded-case AC circuit breaker. Operation of the circuit breaker isolates all phase as well as the neutral.

6.5.9 Fused combination units

Fuse combination unit complies with the requirements of IEC 60947-3 and it is a switch in series with fuses in separate carriers mounted within a single compartment. The required fuse combination units are of the air-break gang operated type with the number of poles specified in schedule A. Provision is made for the fitting of auxiliary contacts to the fuse combination unit for control and indication purposes.

Fuse combination units continuously carry the rated current specified in schedule A when mounted within their compartments and are capable of:

- Making and breaking the rated current in accordance with the utilization category
- Interrupting the rated fused short circuit current.

The fuse combination units fuse carriers and fuses are correctly rated to prevent the melting of fuse carriers.

Fuse combination units are fitted with a device indicating the position of the moving contacts. The position indicator is connected to the moving contacts in a reliable way. The operating handle of the unit forms part of the indicator, provided it cannot indicate the "OFF" position unless all moving contacts ate in the open position. The indicating device is labelled as "ON" or "I" and "OFF" or "O". The indication is clearly visible from the front of the panel.

The battery charger output to the load is controlled by a fuse combination unit. Operation of the fuse-combination unit isolates all two poles.

The UPS rectifier output to the battery bank is controlled by a fuse-combination unit and operation of a fuse combination unit isolates all two poles.

6.6. Batteries and Battery Stands.

6.6.1 *Employer's* quality requirements

The battery manufacturer's quality system complies with 36-698 Rev 0 (GGS 0462 rev 1) Quality requirements for Engineering and Construction works in Generation.

6.6.2 Technical requirements of batteries

(a) Duty cycle and stand-by period

The duty cycle of the load and the required stand-by period is specified in Schedule A. Each battery is able to perform the duty cycle stated in Schedule A for the following operating conditions:

- commence discharge with a new and fully charged battery;
- in the case of flat plate cells 20% extra capacity is allowed for to compensate for deterioration of the cell during its total life at the relative density given in Schedule B;
- in the case of flooded Nickel Cadmium cells 20% extra capacity is allowed for to compensate to ensure that the required load capacity and standby time will be available directly from float during its total life;

- The voltage across the battery terminals and each cell does not fall below the minimum value specified in Schedule A for the duration of the stand-by period; and
- Electrolyte temperature will be as specified by the Battery Manufacturer at ##°C.

(b) Battery types

Stationary Vented Planté or Flat plate Lead Acid Batteries.

Stationary Vented Nickel Cadmium Batteries.

Note: ***No VRLA, Sealed, maintenance free, low maintenance or automotive cells or batteries will be allowed in Generation.***

(c) Nominal ampere-hour capacity

The nominal ampere-hour capacity for flooded lead acid required (10h @ 25°C) and the nominal ampere-hour capacity for flooded Nickel cadmium is specified at the 5h rate in Schedule A. The Contractor offers from his standard range, a battery that complies with the requirements specified in Schedule A and states in Schedule B the relative density of a fully charged cell.

(d) Operating voltages

Each battery operates at a nominal voltage specified in Schedule A.

The minimum and maximum permissible voltage across the battery terminals, due to load and the cable voltage drop is specified in schedule A.

In Schedule B, the Contractor states the recommended voltage per cell for float charging of the battery and the lowest value to which individual cell voltages may be permitted to fall to on discharge.

The recommended float charge voltage per cell meets the following requirements:

- It is sufficiently low that, as long as the cells are held at this voltage, only slight gassing occurs.
- It is sufficiently high that in normal service, and provided no discharge occurs, it causes the cells to be maintained continuously in a charged condition.
- The minimum period over which cells can operate satisfactorily at 25°C, without having to be topped up is at least six months.

(e) Number cells per battery bank

The number of cells battery bank is given in Schedule A.

6.6.3 Arrangement, Mounting and Layout of Batteries

a) Requirements of battery stands

The battery stands are manufactured from polywood/laminated pine. Any other wooden battery stands are not acceptable. The battery stands are manufactured to the requirements of 36-848 (GGSS1000) (Specification for Battery stands at Power Stations). The battery stands are supplied as knocked-down kit complete with all parts necessary to assemble the battery stand on site. The stands are designed to last for the expected life of the battery.

The length and width of the battery stand is such that, the stand carries the desired battery without any danger of toppling over or the cells falling.

The clearance between the floor and struts is not less than 150mm, to enable cleaning of the floor below the bottom row of batteries.

b) Arrangement of batteries

Ideally the total length of a double-tier, double-row stand plus battery is 1200mm (UPS batteries).

The required stand for the 220V AC UPS is a double-tier, double-row battery stand.

The battery is installed such that inspection, testing, filling, and other essential maintenance are carried out safely without hindrance due to lack of space and without disturbing adjacent cells.

No battery stand is positioned against the wall.

There is an access passage to all battery rows, at least 2m wide and a minimum of 1m between rows of battery stands. Rows of battery stands are positioned such that they do not obstruct the emergency exit.

The minimum distance between any battery terminal and the nearest water supply point is 2m.

Battery stands are positioned so that the batteries positive and negative cell pillars are near to a wall, at a maximum distance of 400mm, and a cable entry opening.

The *Project Manager's* acceptance for the design of the stands is obtained prior to commencement of production.

c) Mounting of cells

The required method of mounting cells is face-to-face, regardless of whether the cells are under-square or over-square.

Cells are mounted with a clearance of 100mm between rows of cells on the same battery stand. The 100mm clearance is between cell posts, not containers.

d) Cell insulators

Cell insulators are not required between the under surfaces of the cells and the top surfaces of the stands.

e) Levelling of the battery stand

After assembly is completed the top surface area of the stand is checked to ensure that it is level and any corrections due to a sloping floor are taken care of.

f) Polarity of terminals

Both terminal posts on each cell are clearly and eligibly marked with its polarity.

g) Electrolyte level and relative density

The minimum and maximum electrolyte levels and the recommended fully charged relative density are clearly and eligibly marked on each cell. First filling for Planté cells will be 1195

Specific Gravity for Planté cells will be 1,210 ± 0,005 @ 25 °C.

Specific Gravity for Flat Plate cells will be 1,250 ± 0,005 @ 25 °C.

(As per the manufacturer's specification)

h) Cell identification

The manufacturer's name, type code and year of manufacture are clearly and eligibly marked on each cell.

i) Numbering of cells

Each cell has label giving the number of the cell. These numbers run consecutively, staring with the most positive cell as number one.

Labels are non-conducting material that are unaffected by the environment and remain eligible for the life of the battery.

The adhesive used for the labels is unaffected by the environment and holds labels securely for the life of the battery.

The labels are legible from a distance of 2m and a minimum size of letters is 25mm. The labels have black numbers on a white background or white numbers on a black background.

The labels are fixed to the cells and to the corresponding positions on the stand. The positioning of the labels is such that visual inspection of plates and electrolyte levels is not impeded.

j) Battery label

Each battery bank is provided with a non-conducting battery label mounted on the wall at a reasonable height close to the battery and its cable terminating device.

The label has black/letters numbers on a white background and the minimum size of the letters/numbers is 50mm.

The information required on each battery label is the battery voltage, from where it is fed from and its function.

6.7 Cables, Connectors and Terminal Facilities

6.7.1 Incoming cables (between battery and /UPS)

The arrangement is to provide a stranded PVC-SWA-PVC cable per polarity pole. This cable from the UPS is terminated on a fully insulated cable terminating device. These stranded copper conductors are suitably rated to carry the full load current and withstand short circuit currents. Connection from the cable terminating devices to the actual cell pillar is done by using a suitable solid copper conductor.

6.7.2 Inter-cell connectors

Inter-cell connectors with all the necessary stainless steel bolts, nuts, washers and spring washers are provided and installed by the Contractor. The bolts are correctly sized to suit the cell post hole.

6.7.3 Inter-row connectors between rows of cells on the same stand

Inter-row connectors between rows of cells on the same stand are provided and installed by the Contractor in accordance with the *Employer's* requirements. The inter-row connectors are made of suitable solid copper conductor and painted with white enamel paint.

The *Contractor* states the size of this conductor in Schedule B.

6.7.4 Battery terminating devices

The required number of stainless steel terminal bolts or studs and battery terminating devices for accepting the copper conductors from the cable terminating device is provided and installed by the *Contractor*.

6.7.5 Cable terminating device

The Contractor provides and installs the cable terminating device and the solid copper conductor between this device and the cell pillar. The size of the solid copper conductor is given by the Contractor in Schedule B and painted with white enamel paint as follows:

Red for the positive pole and;

Blue for the negative pole.

The design of the cable terminating device is subject to the Employer's approval. Each pole of a battery is provided with a cable terminating device mounted on the wall or stand nearest to its cell pillar.

This device is positioned that its incoming cable uses the shortest route to leave the batter room through the cable opening for the battery. This device is mounted at a height that allows the copper conductor to be kept as short and rigid as possible.

The device is constructed so that it allows a cable gland plate for the incoming cable and a fully insulated terminal to which the cable and copper conductor from the cell pillar can be connected.

The positive and negative poles and copper conductors of the battery are adequately separated to prevent accidental shorting. The positive and negative pole connections are positioned on the outside of the stand.

6.8 Cell Structural Requirements

6.8.1 Separators

The separators are in sheet form. The length and width of the separators is greater than the length and width of the plates. The life of the separators is equal to the life of the plates.

6.8.2 Plate assemblies

The plates are designed to minimise sedimentation, loss of active material, distortion and buckling. The positive and negative plate assemblies, including separators are rigid when fixed in cell containers.

6.8.3 Cell containers

Containers are transparent and free from bubbles. Internal stresses in containers are relieved by annealing, if appropriate. When resting on a level surface, the containers stand firmly and their top surfaces are horizontal.

6.8.4 Cell assembly

All cells are assembled so that the terminal post positions on adjacent cells will line up with a displacement of not more than 5mm in any plane.

6.8.5 Filler/vent plugs

The filler/vent plugs are readily removable and located to permit easy filling and topping up of cells and the unobstructed use of a hydrometer.

The plugs permit free escape of gases from the cells but allow electrolyte vapour to be trapped and returned to cells.

6.9 General Information

The *Contractor* submits fully-dimensioned outline drawings and tables from which the following information is obtained:

- Overall width (horizontal dimension parallel to plate surface)
- Overall length (horizontal dimension perpendicular to plate surface)
- Height to the top of the cell cover.
- Overall height to the top of the terminal post
- Mass of one cell, complete and filled
- Quantity of electrolyte per cell

6.10 Miscellaneous

6.10.1 Rail mounted terminal blocks

The Klippon spring loaded terminals detailed in Schedule A are used. It is possible to replace any unit in an assembly without dismantling adjacent units.

The number and size of ac terminals are provided in accordance with the number of ac phases and maximum battery charger current as detailed in Schedule A.

The outgoing dc terminals are the screw clamp type, of suitable rating and size for the cable specified in Schedule A.

Terminals for remote are provided as detailed in Schedule A.

Battery terminals are provided in accordance with the cable sizes detailed in Schedule A.

The following type of terminals is acceptable:

- Screw clamp type and spring loaded insertion type.
- Stud type and bolt type for cable lugs.

6.10.2 Wiring

All wiring is PVC. Not more than two conductors are connected to any one terminal. All wires and cables are terminated with pre-insulated crimped lugs. All terminations are made with the tool recommended by the manufacturer of lugs. Crimping tools are of the type that will not release the termination during normal operation until the conductor crimp has been correctly formed. All wiring passing through holes is protected by grommets. Wiring leads are marked at both ends with a slip on type ferrule. The slip on type ferrule is permanently marked with black letters impressed on a white or yellow background. Power wiring is marked to indicate the pole to which it is connected. The positive and negative wires are red and blue respectively. Control circuits are coloured black for ac circuits and grey for dc circuits.

6.10.3 Labels

All labelling is done in accordance with ESKOM drawing number 0.54/3695 sheet 1 and 2 MV, LV and DC switchgear labels and nameplate details. All outgoing circuit breakers are provided with blank labels, fixed by means that will allow easy removal for future engraving.

7. General

7.1 Configuration Management

The *Contractor* updates the design drawings, operating and maintenance manuals and any other documentation to include and indicate the as-built status each unit in accordance with the following requirements.

7.2 Plant Codification

A common alpha-numeric designation system for the codification of all items of plant, plant and material and components is used for the whole power station.

The *Contractor* is fully familiar with the standards and concepts of the AKZ system as applied by the *Employer.*

The *Contractor* codifies all plant, material and components in his supply for which the *Works* Information and Contract Data indicates he is responsible.

The specific AKZ-code of each item of plant, material, component, measuring joint, junction box, cable, etc. appears on all documents, instruction manuals, schedules, drawings (i.e. flow diagrams, general arrangements, schematic diagrams, cable block diagrams, etc), and labels for plant, material and components.

The *Contractor* provides a list of all AKZ-codes used in accordance with standard documentation.

The relevant AKZ-code is included on the label according to the required format, together with plant description and classification code. This is prepared on the IGIS data base issued by the *Employer.*

The allocation of all codes is accepted by the *Project Manager.* The *Contractor* ensures that the code is applied in a uniform and consistent way and that all codes allocated are unique.

The format of the code is an alpha-numeric code consisting of four breakdown levels as follows:

Serial Number of Breakdown Level	0	1				2				3			
Name of Breakdown Level	**TOTAL PLANT**	**FUNCTION**				**UNIT PLANT**				**UNIT COMPONENT**			
Designation Of Data Character	G	F0	F1	F2	F3	FN	A 1	A 2	AN	A3	B1	B2	BN
Nature of Data Character	N	N	A	A	A	N	N	A	A	N	N	N	A	A	A	N	N

Where A = Alpha symbols for class identification

N = Numerical symbols for item identification

The code is written and engraved in the following format:

N N A A A N N A A N N N A A A N N

e.g. 1 0 L A C 1 0 A P 0 0 1 - - 0 1

The *Contractor* uses all levels of the coding system to ensure clear identity of plant, material and components.

7.3 Bar-Coding

None.

7.4 Plant Description

The description is sub-divided into three main categories after the particular unit has been defined in the description namely:

7.4.1 Plant

Describing the plant item associated to a particular process function, e.g. Mill, turbine, electric feed pump, condenser etc.

The plant Number is the numeral or alphabet letter used to identify which similar plant e.g. 2, 4, A or B etc

7.4.2 Medium

The process medium associated to the component being described, e.g. Secondary air, flue gas, feed water, etc.

7.4.3 Components

The components position is stated first e.g. Left-hand etc.

7.4.4 Nameplates

Each cubicle has a stainless steel or anodized aluminium plate on which the following information is engraved:

- The ac nominal voltage, maximum ac current drawn and number of phases.
- The nominal dc output voltage and the float, auto boost, equalise voltages.
- The permissible dc range of load voltage.
- ESKOM Serial number.
- ESKOM specification number.
- ESKOM order number.

8. Relevant related performance standards

9. Document availability

This document can be accessed electronically via the Eskom Intranet and the FTR system.

10. Records

All certified test authority certificates must be submitted as part of the design package.

Type testing reports for every type charger must be compiled and submitted to the Power Station.

11. Annexes

Appendix A.

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

APPENDIX A

36-817 REV 0

SCHEDULE A & B - Static Uninterruptible Power Supplies

Schedule A: The Engineer's particular requirements

Schedule B: Guarantees and technical particulars of equipment offered

All Standards quoted will be the Latest revision

NOTES REGARDING THE COMPLETION OF SCHEDULE A & B:

NOTE: The schedules A&B of the Battery Charger Specification 36-815 must also be completed and submitted as part of these schedules.

General

The requirements of this section specified under "Schedule A & B" form part of the Works Information. Schedule B must be completed by the Contractor and submitted with his tender.

Filling in Instructions

- Where the Contractor does not fully comply with the Engineering requirement, any deviations must be clearly indicated in Schedule B and listed in the Deviation Schedule, with the cost of the deviation.
- Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.
- If a blank space is left in Schedule B next to certain requirements specified in Schedule A, this constitutes a confirmation that the tender does not comply with that specific requirement.
- Where xxxxx is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.
- Where t.b.c. (to be confirmed) is indicated for an item in Schedule A, the Engineer will fill in the appropriate information in Schedule A, when confirmed.

Evidence Reference

- Each evidence reference shall be filled in with a reference to the delivery documentation where the word "REQUIRED" is stated. The evidence reference section will refer to the documentation that backs-up the statement made in Schedule B. If no evidence is received or it is not referenced to correctly, it shall be taken as non-compliance with regard to Schedule A.

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
1	**General**	Fully Microprocessor Controlled with all Rectifier functions, Alarms and Monitoring Functions	Fully Microprocessor Controlled with all Rectifier functions, Alarms and Monitoring Functions		**Full Compliance Required**	
1.1	Project	Single/Dual Redundant Parallel Master & Slave UPS	Single/Dual Redundant Parallel Master & Slave UPS		**Required**	
	AKZ/KKZ coding of the equipment required. To be Supplied by Eskom	Yes/No	Yes			
1.2	**Service Conditions**					
	Altitude	Info			**Information**	Refer to Section 3a
	Minimum temperature	Info	5°C		**Information**	
	Maximum temperature	Info	40°C		**Information**	
	Atmosphere	Info	Dry and dusty		**Information**	
	Relative humidity range	Percentage	85%		**Information**	
	High lightning area	Yes/No	Yes.		**Information**	
	Maximum battery room temperature. °C	Temperature	25 °C ± 1°C		**Information**	
	Minimum battery room temperature. °C	Temperature	25 °C ± 1°C		**Information**	
2	**System conditions**					
2.1	**400V AC Electrical supply characteristics for UPS**					
	Output voltage.	400 V 3 Phase with Neutral	400 V 3 Phase with Neutral		**Required**	
	Tolerance	Percentage	- 3% to 5%		**Required**	
	Input voltage.	400 V 3 Phase with Neutral	400V		**Required**	
	Tolerance	Percentage	- 20% to 20%		**Required**	
	Minimum Input? Frequency.	Frequency (Hz)	47Hz		**Required**	
	Maximum Input Frequency.	Frequency (Hz)	51Hz		**Required**	
	Total input harmonic distortion at full load.	Percentage	5%		**Required**	
	Number of phases.	Detail	Three + neutral.		**Required**	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Details of earthing ac input system	Detail	Neutral solidly earthed.		Required	
2.2	**Parallel redundant configuration required**	Yes/No	Yes		Required	
2.2a	Units parallel able up to (n..) units by simply adding another UPS in parallel with the existing system	Yes/No	Yes		Required	
2.2b	Paralleling is achieved by plug in modules and plug in signal cable	Yes/No	Yes		Required	
2.2c	Parallel units equally sharing load current	Yes/No	Yes		Required	
2.2d	It shall be possible to isolate any one unit without switching to bypass	Yes/No	Yes		Required	
2.2e	Reverse current monitoring circuit shall be included in each inverter to detect any circulating currents	Yes/No	Yes		Required	
2.2f	During parallel operation the inverter oscillators and are electronically phase locked are both synchronized to the SBS supply	Yes/No	Yes		Required	
2.2g	Reverse current detection ensures immediate inverter shutdown	Yes/No	Yes		Required	
2.3	**Parallel method**	Direct/Paralleling TRFR	Direct, no paralleling transformer		Required	
2.4	**UPS type**	On line Double conversion technology	On line Double conversion technology		Required	
2.4a	**RF Interference (IEC 60146-4 sub-clause 7.4.26)**	Proof to be Supplied			Certificate to be supplied	
2.5	**Noise generation (IEC 60146-4 sub-clause 7.4.28)**	dBA	Less than 53 dBA		Certificate to be supplied	
2.6	**Safety compliance**	Proof to be Supplied	EN 50091-1		Certificate to be supplied	
2.7	**EMC Compliance**	Proof to be Supplied	EMC EN 50091-2		Certificate to be supplied	
2.8	**Degree of protection**	IP Rating	IP20		Required	
3	**Subsystems.**					
	Bypass Isolation transformer delta star of UPS rating	Yes/No	Yes		Required	
	Forced air cooling	To be Specified	Fans		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Fan speed to be controlled and determined by UPS loading in order to increase fan life expectancy	Yes/No	Yes		Required	
	Bottom entry panel with air exhausting out of the rear	Yes/No	Yes		Required	
	Modularity, power stacks and controls to be rack out design	Yes/No	Yes		Required	
	Input harmonic current distortion cancellation using 12 PULSE RECTIFIER	THDI	< 8 % THDI		Required	
3.1	**Rectifier operational requirements.**				Required	
	Rectifier description Fully Microprocessor Controlled Thyristor/IGBT bridge	Fully Microprocessor Controlled three phase Thyristor bridge	Fully Microprocessor Controlled three phase Thyristor bridge		Required	
	Rectifier type	Fully Microprocessor Controlled three phase Thyristor bridge	**12 Pulse**		Required	
	Nominal charger dc voltage.	Voltage (V)	231 V DC		Required	
	Battery float voltage per cell. Comply to full voltage range	Voltage (V) per cell	2.15 to 2.3 (Flooded Lead Acid). 1.40 to 1.45 (Flooded Nickel Cadmium)		Required	
	Battery auto-boost voltage per cell. Comply to full voltage range	Voltage (V) per cell	2.25 to 2.3 (Flooded Lead Acid). 1.45 to 1.55 (Flooded Nickel Cadmium)		Required	
	Battery equalise charge voltage per cell. Comply to full voltage range	Voltage (V) per cell	2.25 to 2.7 (Flooded Lead Acid) 1.55 to 1.70 (Flooded Nickel Cadmium)		Required	
	Battery initial charge voltage per cell. Comply to full voltage range	Voltage (V) per cell	2.7 to 3 (Flooded Lead Acid). Adjusted to 1.8 (Flooded Nickel Cadmium)		Required	
	Is initial charge capability required. **(Commissioning)**	Yes/No	Yes		Required	
	Limit of battery charging current. A	% Ah	15% Ah		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Battery float current. A	% Ah	15%Ah		Required	
	Battery auto-boost current. Comply to full voltage range A	% Ah range	Between 3.5% & 10%Ah		Required	
	Battery equalise current. Comply to full voltage range A	% Ah range	Between 3.5% & 10%Ah		Required	
	Maximum recharging time following most onerous duty cycle	Hours	10 hours.		Required	
	Maximum rms. Ripple voltage on DC output %	2.5	2.5		Required	
	Maximum rms. ripple current A	Percentage	Ah x 3%		Required	
	Inverter disabled under initial charge conditions?	Yes/No	Yes		Required	
	Rectifier to perform automatic battery test with monitoring and comparison to previous self test	Yes/No	Yes		Required	
	Self test to take into account inverter loading at that time and compare battery performance accordingly	Yes/No	Yes		Required	
	A difference in the battery performance to give an audible alarm	Yes/No	Yes		Required	
	Common battery configuration possible i.e. 1 battery set can be connected to two or more UPS units	Yes/No	Yes		Required	
	Cross feeding possible with common battery configuration	Yes/No	Yes		Required	
	Low battery disconnect with contactor	Yes/No	Yes		Required	
	Battery overload and short circuit protection with fuses	Yes/No	Yes		Required	
	Inrush current into the Rectifier limited	To be Supplied	xxxxx		Required	Refer to sub clause 6.3.7 item (d)
	Rectifier capable of handling Inrush current without damage or malfunction	Yes/No	Yes		Required	Refer to sub clause 6.3.7 item (d)
3.2	**Inverter and static bypass**					
3.2.1	**Output voltage.**					
	a) 400V Three-phase four wire system	Yes/No.	Yes.		Required	
	b) phase angle tolerance. ° (deg)	Specified	≤1° with balanced		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
			load			
	c) voltage tolerances. %	Percentage	Steady-state <1% with balanced load		Required	
3.2.2	**Output frequency.**					
	a) tolerances.	Percentage	< 0.05% self-clocked.		Required	
	b) maximum slew rate. Hz/s	Specified	1 Hz/sec		Required	
3.2.3	**Total harmonic content.**					
	a) Maximum single harmonic. %	Percentage	≤3 % with linear load		Required	
	b) Maximum harmonic distortion %	Percentage	≤5 %		Required	
3.2.4	**Voltage stability.**					
	a) 100% step load. %	Percentage	<5%		Required	
	b) Recovery time to 100% ms	ms	<5ms		Required	
3.2.5	**Overload capability.**					
	a) 125% overload duration. Min.	minutes.	10 minutes.		Required	
	b) 150% overload duration. Sec.	seconds.	60 seconds.		Required	
3.2.6	**Short circuit capability required?**	Yes/No.	Yes.			
	a) duration of a single-phase short circuit current of 2.1x In	seconds.	1s		Required	
	b) duration of a single-phase short circuit current of 1.5x In.	seconds.	10s		Required	
3.2.7	DC input voltage range. (DC Bus) V	Voltage Range	220 to 280 Vdc		Required	
3.2.8	Inverter load disconnect contactor	Yes/No	Yes		Required	
3.2.9	**Static bypass switch**					
	a) Single phase full bridge	Yes/No	Yes		Required	
	b) Contactor in parallel with static bypass thyristors	Yes/No	Yes		Required	
	c) Overload capacity for 1 minute	Percentage	200%		Required	
	d) Transfer time @ full load with Inverter Fails	msec	0 msec		Required	
3.3	**Metering, controls, alarms and indicators.**					

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
3.3.1	Meters.	Information to be supplied	xxxxx		Required	
	a)type of meters.	Information to be supplied	LCD display.		Required	
	b)parameters displayed.	Yes/No	Yes		Required	
	c)battery voltage.	Yes/No	Yes		Required	
	d)battery current.	Yes/No	Yes		Required	
	e)output ac voltage/phase.	Yes/No	Yes		Required	
	f)output ac current/ phase.	Yes/No	Yes		Required	
	g)output frequency.	Yes/No	Yes		Required	
3.3.2	**Controls.**					
	a) alarm acknowledge	Yes/No	Yes		Required	
	b) alarm reset.	Yes/No	Yes		Required	
	c) equalise mode	Yes/No	Yes		Required	
	d) rectifier on/off	Yes/No	Yes		Required	
	e) inverter on /off	Yes/No	Yes		Required	
	f) switchable meters	Yes/No	Yes		Required	
	g) type of switch for a) to f)	Information to be supplied	Membrane keyboard.		Required	
	h) Remote inverter on/off	Yes/No	Yes		Required	
	i) Remote system shutdown	Yes/No	Yes		Required	
	Software					
	j) Control and monitoring and shutdown software to be supplied giving UPS status, system and fault analysis and Event history	Information to be supplied	xxxxx		Required	
	k) Software to have multi program and multi platform capabilities	Information to be supplied	xxxxx		Required	
	l) Event schedule to be included	Information to be supplied	xxxxx		Required	
	m) Network interface SNMP Adapter to be provided per UPS unit	Information to be supplied	xxxxx		Required	
	n) Remote service and interrogation of machines	Information to be supplied	xxxxxx		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
3.3.3	**Alarms. (Wall mounted remote alarm panel)**					
	Mimic panel provided.	Yes/No.	Yes.		Required	
	a) dimensions (H x W)	Information to be supplied	xxxxx		Required	
	b) alarm indications on mimic	Yes/No	Yes		Required	
	c) LED indications	Yes/No.	Yes.		Required	
	d) LC display for monitoring and diagnostic system.	Yes/No.	Yes.		Required	
3.3.4	**Front panel alarms.**					
	a) mains available	Yes/No	Yes		Required	
	b) rectifier operation.	Yes/No.	Yes.		Required	
	c) battery operation	Yes/No.	Yes.		Required	
	d) battery under-voltage.	Yes/No	Yes		Required	
	e) boost charge.	Yes/No.	Yes.		Required	
	f) equalise charge.	Yes/No.	Yes.		Required	
	g) inverter operation.	Yes/No	Yes		Required	
	i) static bypass on	Yes/No.	Yes.		Required	
	j) manual bypass on	Yes/No.	Yes.		Required	
	k) UPS output failure	Yes/No.	Yes.		Required	
	l) legend describing alarms on front panel.	Yes/No.	Yes.		Required	
3.3.5	**Remote alarm contacts.**					
	a) mains available	Yes/No	Yes		Required	
	b) rectifier operation.	Yes/No.	Yes.		Required	
	c) battery operation	Yes/No.	Yes.		Required	
	d) battery under-voltage.	Yes/No	Yes		Required	
	e) boost charge.	Yes/No.	Yes.		Required	
	f) equalise charge.	Yes/No.	Yes.		Required	
	g) inverter operation.	Yes/No	Yes		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	i) static bypass on	Yes/No.	Yes.		Required	
	j) manual bypass on	Yes/No.	Yes.		Required	
	k) UPS output failure	Yes/No.	Yes.		Required	
3.4	**Protection.**					
3.4.1	**Mains feeder.**					
	a) Circuit breaker	Yes/No	Yes		Required	
	b) Rating.	Amps			Required	
	c) Manufacturer	Information to be supplied	xxxxx		Required	
3.4.2	**Input protection rating.**					
	a) UPS units	Circuit breaker Amps	xxxxx		Required	
	b) static bypass.	Circuit breaker Amps	xxxxx		Required	
	c) manual bypass.	Fuse Amperage	xxxxx		Required	
3.4.3	**Output protection rating.**					
	a) UPS units	Circuit breaker and contactor (Amps)	xxxxx		Required	
	b) static bypass.	Circuit breaker and contactor (Amps)	xxxxx		Required	
	c) manual bypass.	Amps			Required	
3.4.4	**Battery isolation.**					
	a) Fused Isolator	Yes/No	Yes		Required	
	b) Rating.	Amps			Required	
	c) Manufacturer.	Information to be supplied	xxxxx		Required	
4	**Performance requirements.**					
4.1	**Load configuration.**					
	a) single phase loads.	Yes/No	Yes		Required	
	b) three phase loads	Yes/No	Yes		Required	
4.2	**Load characteristics.**					

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	a) type of loads.	Computers, power supply units, convertors	Computers, power supply units, convertors		Required	
	b) Load unbalance	Percentage %	100		Required	
	c) non-linear loads	Yes/No.	Yes.		Required	
4.3	**Efficiency.**					
	a) @ 25% load %	Percentage %	91		Required	
	b) @ 50% load %	Percentage %	92		Required	
	c) @ 100% load %	Percentage %	91.5		Required	
4.4	**Audible noise. dB(A)**	dB(A)	<55		Required	
5	**Cubicle requirements.**					
5.1	**Loading on foundations.**					
	Overall mass of complete UPS.	kg	xxxxx		Required	
5.2	**Material thickness.**					
	Supporting structure.	mm	2		Required	
	Cover plates	mm	2		Required	
	Removable covers.	mm	2		Required	
	Doors.	mm	2		Required	
	Equipment mounting panels.	mm	2		Required	
5.3	**UPS operation and cable access.**					
	Front operation with front bottom cable access.	Yes/No.	Yes.		Required	
	Cable entry from below.	Yes/No.	Yes.			
5.4	**Base frame.**					
	Height.	mm	xxxxx		Required	
	Material thickness.	mm	xxxxx		Required	
5.5	**Door fasteners**				Required	
	Charger equipment compartment doors front only		Metal with a padlockble lever		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Cable compartment doors		Metal with a 6mm square key drive		Required	
5.6	**Cable securing arrangement.**					
	Gland plates	Yes/No.	Yes.		Required	
	Height of the gland plate above floor level	mm minimum	300mm minimum		Required	
5.7	**UPS cubicle finish**					
	Specification for corrosion protection.		OPS 2365/11-3		Required	
	Thickness		50 microns		Required	
	Colour		Light grey G29		Required	
	Surface finish		epoxy powder coated		Required	
	Equipment mounting tray (panel)				Required	
	Thickness		60 microns.		Required	
	Colour		White.		Required	
	Surface finish		High gloss.		Required	
5.8	Degree of protection (to IEC 947-1in conjunction with IEC529)	IP Rating	IP 20		Required	
5.9	Indoor installation.	Yes/No.	Yes.		Required	
6	**Terminals.**					
	AC and DC Supply terminals.		xxxxx		Required	
	Manufacturer.		Klippon.		Required	
	Type designation		Stud type as shown on 0.00/5005 and 0.00/1285.		Required	
	Control terminals.		xxxxx		Required	
	Manufacturer		KLIPPON or equivalent		Required	
	Type designation.		RSF-1 spring loaded as shown on 0.00/5005 and 0.00/1285.		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
7	**Labels.**					
	Labelling	Yes/No	Yes		**Required**	
	Language taking precedence.	English.	English.		**Required**	
8	**Batteries and battery stands**					
8.1	**Technical requirements.**					
	Number of battery banks required.	Number	xxxxx		**Required**	
8.1.1	**Duty cycle.**					
	Design value of average load current drain	Amps (A)	xxxxx		**Required**	
	Required standby period per Battery Bank. As per 36-725 Rev 0	Hours	xxxxx		**Required**	
	Duty cycle graph attached.	Yes/No	Yes		**Required**	Refer to Section 3.3.3
	Comply with operating conditions.	Yes/No	Yes		**Required**	
8.1.2	**Type of {Flooded} lead acid / Nickel Cadmium battery offered. {No Sealed or Maintenance Free Cells}**	**No Sealed or Maintenance Free Cells**	**No Sealed or Maintenance Free Cells**			
	Planté or Flat Plate (To be specify by Eskom)	Planté / Flat Plate or Nickel Cadmium	xxxxx		**Required**	
	Battery manufacturer's name.	To be Specified	xxxxx		**Required**	
	Cell code	To be Specified	xxxxx		**Required**	
	Ampere-hour capacity (10h rate at 25°C)	Ah	(10h rate at 25°C)		**Required**	
	Capacity determined by the Employer.	Ah	xxxxx		**Required**	
	Capacity determined by the Contractor.	Ah	xxxxx		**Required**	
	Capacity offered by the Contractor.	Ah	xxxxx		**Required**	
	Has the cell been sized for 20% spare capacity? {Only in case of Nickel Cadmium)	Yes/No	NO		**Required**	
	Internal impedance of a cell under fully charged conditions. Impedance calculation is for 60s @ 25°C to 1.7V/cell.{Flooded Lead Acid}	mΩ	xxxxx		**Required**	
	Instantaneous short-circuit current	Amps (A)	xxxxx		**Required**	
	Short-circuit current after 1s.	Amps (A)	xxxxx		**Required**	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Relative density	To be Specified	xxxxx		Required	
	Normal	To be Specified	xxxxx		Required	
	Maximum with electrolyte at minimum.	To be Specified	xxxxx		Required	
8.1.3	**Operating voltages.**					
	Nominal operating voltage.	Voltage (V)	231		Required	
	Permissible minimum voltage across battery terminals.	Voltage (V)	223		Required	
	Permissible maximum voltage across battery terminals.	Voltage (V)	280		Required	
	Recommended float charge voltage per cell.	Voltage (V) per Cell	xxxxx		Required	
	Lowest permissible cell voltage on discharge.	Voltage (V) per Cell	As per the manufacturer		Required	
8.1.4	**Current drain.**					
	Design value of average load current drain.	Amps (A)	xxxxx		Required	
	Guaranteed maximum continuous discharge current offered by the Contractor for the specified operating conditions.	Amps (A)	xxxxx		Required	
8.1.5	**Number of cells per battery.**					
	Proposed by the Employer.	Number			Required	
	Recommended by the Contractor.	Yes/No	xxxxx		Required	
	Available floor area for battery sufficient?	Yes/No	xxxxx		Required	
8.1.6	**Charging details.**					
	Maximum recommended float current.	Amps (A)	xxxxx		Required	
	Minimum recommended float current.	Amps (A)	xxxxx		Required	
	Maximum recommended equalising current.	Amps (A)	xxxxx		Required	
	Range of current selection for initial/commissioning charge of battery.	Amps (A)	xxxxx		Required	
8.1.7	**Auto boost charge.**					
	Recommended low voltage to initiate auto boost charge.	Voltage (V) per Cell	xxxxx		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Predetermined time interval to initiate auto boost. Days. See Eskom specification	Days	28		Required	
	Preset voltage level to revert battery charger back to float.	Voltage (V) per Cell	xxxxx		Required	
	Maximum time after preset voltage has been reached to revert to float if current facilities are not used.	Hours	xxxxx		Required	
8.1.8	**Equalising charge.**					
	Recommended interval. Months	Months	xxxxx		Required	
	Charging current rate.	Amps (A)	xxxxx		Required	
	Charging voltage per cell	Voltage (V) per Cell	xxxxx		Required	
8.1.9	**AC component of charging current.**					
	Maximum permissible value for battery offered.	Amps (A)	xxxxx		Required	
8.1.10	**Efficiency and service life.**					
	Guaranteed efficiency at 25°C (discharge @ 10h rate to 1.85V/cell){ Lead Acid}	Discharge @ 10h rate to 1.85V/cell){ Lead Acid} and 1.00V/cell @ 5 Hr rating for Nickel Cadmium	xxxxx		Required	
	Ampere-hour efficiency	Percentage %	xxxxx		Required	
	Watt-hour efficiency	Percentage %	xxxxx		Required	
	Guarantee period	Years	xxxxx		Required	
	Period over which fully efficient and reliable service may be expected. Years	To be Specified by Sypplier	xxxxx		Required	
	Minimum cell capacity still available @ the end of life.	Percentage %	80%		Required	
	Period for which cells may be stored in a dry condition, without detrimental effects.	Months	xxxxx		Required	
8.2	**Arrangement, mounting and layout.**					
	Do arrangement, mounting and layout comply with the specified requirements?	Yes/No	xxxxx		Required	
8.3	**Battery stands.**	Manufacturer	xxxxx			
	Are battery stands required? To be specify by Eskom	Yes/No	Yes		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Number of battery stands required.	Info to be Supplied	xxxxx		Required	
	Assembly drawings for battery stands?	Yes/No	Yes		Required	
	Drawing for acceptance attached?	Yes/No	Yes		Required	
	Battery stands built to the requirements of 36-848 Rev 0.	Yes/No	Yes		Required	
	Double-tier, double-row cell arrangement.	Yes/No	Yes		Required	
	Length	mm	xxxxx		Required	
	Width	mm	xxxxx		Required	
	Height (max 1200mm including battery)	Info to be Supplied	xxxxx		Required	
8.4	**Mounting of cells.**					
	Face-to-face	Yes/No	Yes		Required	
8.5	**Inter-cell connectors.**					
	Total cross-sectional area	mm2	xxxxx		Required	
	Material.	Specified	xxxxx		Required	
8.6	**Inter-row connectors.**					
	Total cross-sectional area	mm2	xxxx		Required	
	Material.	Specified	xxxxx		Required	
8.7	**Battery terminating device.**					
	Type of battery terminating device (bolt or stud/nut)	Specified	xxxxx		Required	
8.8	**Cable terminating device.**					
	Wall mounted on one end.	Yes/No.	Yes.		Required	
	Stand mounted on the other end.	Yes/No.	Yes.		Required	
	Sketch of terminating device.	Yes/No	Yes		Required	
	Are drawings submitted for acceptance.	Yes/No	Yes		Required	
8.9	**Cell structural requirements.**					
	Do cells comply with the requirements specified?	Yes/No	Yes		Required	
	Have cell drawings and tables been submitted as	Yes/No	Yes		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	specified.					
	Overall width	mm	xxxxx		Required	
	Overall length	mm	xxxxx		Required	
	Height to top of cell cover.	mm	xxxxx		Required	
	Overall height to top of terminal post.	mm	xxxxx		Required	
	Weight of one filled cell	kg	xxxxx		Required	
	Electrolyte per cell	l	xxxxx		Required	
8.10	**Instruction manuals.**					
	Number of hard copies	Number	4		Required	
	Number of electronic hard copies	Number	2		Required	
8.11	**Drawings.**					
	Do instruction manuals comply with the specified requirements.	Specified			Required	
	Drawings for approval attached	Yes/No.	Yes		Required	
	Set of discharge curves attached	Yes/No.	Yes		Required	
	Set of recharge curves attached	Yes/No.	Yes		Required	
	Set of calculation sheets attached	Yes/No.	Yes		Required	
8.12	**Testing.**					
	Have cells been type tested by ESKOM?	Yes/No.	xxxxx		Required	
	Has your technical data been verified?	Yes/No.	xxxxx		Required	
	Do you perform routine tests during your manufacturing process?	Yes/No.	xxxxx		Required	
	Do you comply with ESKOM procedure 36-965 Rev 0	Specified	xxxxx		Required	
8.13	**Labels.**					
	Labelling of battery charger and panel		See 0.54/3695 Sheet 1 and 2.		Required	
	Language taking precedence.	English.	English.		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Labelling of cells according to 36-813 Rev 0	Yes/No	xxxxx		Required	
8.14	**Miscellaneous.**					
	Access to site by	Eskom to Specify	Road.			
	Off –loading from transporting vehicle required.	Yes/No	Yes			
	Crane for off-loading.	Yes/No	xxxxx			
	Erection on prepared foundations	Yes/No	Yes			
	Number of tool sets required	Two	Two		Required	
	Number of ESKOM personnel to be trained.	8	8		Required	
	Training duration.	Specify	xxxxx		Required	
	Training venue	Specify	xxxxx		Required	
	Factory Acceptance Testing required	Yes/No	Yes		Required	
	Routine testing required	Yes/No	Yes		Required	
8.15	**Experience and other requirements**					
	List of ESKOM Generation sites installed within the last 2 years with complaint equipment offered.	Proof to be Supplied	Yes		Required	
	Priced spares list to be provided	Yes/No	Yes		Required	
	List of personnel and their experience on equipment offered to be provided	Proof to be Supplied	Yes		Required	
	UPS Manufacturers experience and history to be provided	Yes/No	Yes		Required	
	Spares Guaranty/Warranty (10 Years Plus)	Minimum 10 Years	xxxxx		Required	
	List of spares and quantities held by appointed contractor to be provided	Yes/No	Yes		Required	
	The UPS shall have its own fault diagnostics indicating which section of the UPS is under a fault condition	Yes/No	Yes		Detailed information to be supplied	
	Are you accredited by the Manufacturer and Eskom Generation to commission there cells.	Supply Proof of accreditation	xxxxx		Supply Proof	
	An event memory shall be available to assist with diagnostics	Yes/No	Yes		Required	
	Detailed fault analysis flow charts to be provided	Yes/No	Yes		Required	

Enquiry No.: ..... Tenderer's name: .....

Project Name: ..... Date: .....

Item	Description		Schedule A	Schedule B	Evidence reference	Comments
	Detailed fault analysis descriptions to be provided	Yes/No	Yes		Required	
	Detailed drawings to component level to be provided.	Yes/No	Yes		Required	
	Detailed card component layout drawings to be provided.	Yes/No	Yes		Required	
	Detailed lists of measurement points to assist in fault diagnostics to be provided	Yes/No	Yes		Detailed information to be supplied	
8.16	DISTRIBUTION BOARDS					
	Each set of two UPS units to be provided with a floor standing input/output/dc db	Yes/No	Yes		Required	
	Input section to have feed to both UPS's and system detour feed as per drawing (Supplied by Contractor)	Yes/No	Yes		Required	
	DC section to contain battery protection and interlock for equalise charging	Yes/No	Yes		Required	
	Output section to have feed from both UPS's and system detour feed as per drawing. (Supplied by Contractor)	Yes/No	Yes		Required	

APPENDIX B

DEVIATION SCHEDULE

Any deviation from the Works Information and Specifications, or alternatives offered, are listed below with reasons and estimated cost for departure from the specification. If no deviations or alternatives are offered, this schedule must be marked (N/A).

Specification or Schedule Number	Specification or Clause Number	Proposed Deviation or Alternative	Cost of Deviation or Alternative