

SECTION- 4
AUXILIARY POWER SUPPLY SYSTEM

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SECTION- 4

AUXILIARY POWER SUPPLY SYSTEM

4.0 General

This section describes the technical requirements for Auxiliary Power Supply System. The BOQ for Auxiliary Power Supply system equipments required for SCADA/DMS control centre, RTU/Data Concentrator, FRTU Communication equipment & remote VDU locations. The components of Auxiliary Power Supply system are Uninterruptible Power Supply (UPS), 48V DC power supply (DCPS), the batteries for UPS and DCPS. The technical requirements for all the above components are described in the various subsequent clauses.

The Bidder is encouraged to offer their standard products and designs. The UPS, DCPS, Battery shall be manufactured & tested as per the relevant IS/IEC/ EN/BS standards. However, the Bidder shall conform to the requirements of this specification and shall provide any special interface equipment necessary to meet the requirements stated herein.

All equipment except Batteries shall be designed for an operating life of not less than 15 years, however, batteries shall have a minimum expected operating life of 5 years under normal operating conditions or 1200 charge/discharge cycles (whichever is earlier). The Contractor shall demonstrate the functionality of the equipment during tests in the factory. After the equipment is installed, the Contractor shall demonstrate all of the functions during well-structured field tests.

4.1 Uninterruptible Power Supply (UPS)

The technical requirements for the Uninterruptible Power Supply (UPS) System and associated equipments to be provided by the contractor are described below.

The UPS system shall include the following:

- UPS equipments supplying load at 0.8 lagging power factor
- VRLA batteries for UPS system with backup duration
- UPS input and output AC Distribution Boards.
- Power, control and network cables

4.1.1 UPS Functions

The UPS shall be designed for continuous-duty, on-line operation and shall be based on solid-state design technology to provide uninterrupted power supply for computer system and associated items. The control of the UPS system shall be microprocessor based providing monitoring and control of rectifier/charger, Inverter, static switches, firing and logic control.

Each UPS system provided by the Contractor shall include all of the following sub-systems as well as any other components and support hardware necessary for complete and proper operation of the UPS:

- a) Rectifier/charger unit
- b) Inverter unit
- c) Battery Low Voltage Disconnect device
- d) Static bypass switches
- e) Manual maintenance bypass switches
- f) Isolation transformer
- g) Load transformer and filters
- h) Control panels including source selection equipment & ACDBs, automatic controls and protection
- i) Hardware and software as required for parallel operation of two no of UPS systems
- j) All necessary cables, MCCBs/MCBs/ switches/ fuses

In the event of a loss of AC source, the UPS equipment shall provide uninterrupted power to the critical loads from the output of the UPS inverter subsystems through batteries.

4.1.2 UPS Operation

The UPS systems with associated batteries shall operate in parallel redundant configuration sharing the connected load. The conceptual diagram for UPS is shown in figure 4-1.

The UPS shall primarily use the inverter subsystem to deliver AC power to the computer loads. In case of failure of any one of UPS, the other healthy UPS shall continuously supply the power to the computer loads without any interruption. If the other healthy UPS also fails then automatically Static bypass of UPS shall start supplying the connected load through AC mains without any interruption.

The Manual Maintenance Bypass shall be provided for each of the UPS separately to extend AC raw power supply to computer systems in case of complete failure or shutdown of UPS systems.

The facilities shall also be provided to manually control the UPS through its control panel.

4.1.3 UPS Equipment Design

The design of the UPS shall have the capability to isolate any failed piece of equipment viz. Rectifier/charger unit, inverter and battery for maintenance. UPS equipment design shall consider the following electrical parameters:

- UPS equipment shall comply to IEC 62040 or equivalent. EN/BS standards for design, performance and EMC requirements.
- The input mains AC supply to the UPS shall be 415 volt AC, 3-phase, 4-wire,

50 Hz. The input supply voltage may vary +10% to -15% from nominal and the frequency may vary from 47.5 to 52.5 Hertz.

- The UPS shall be suitable for operation on Mains input AC on phase sequence reversal.
- The UPS shall provide 3-phase four wire output plus ground.
- The UPS shall supply power to the connected loads at 415 volt AC, 3-phase, 50 Hz., 0.8-lagging power factor.
- The UPS shall provide continuous regulated sine wave AC power to the connected loads.
- The overall efficiency of the UPS, input to output, shall be a minimum of 90 percent with the batteries fully charged and operating at full load and unity power factor.
- Noise generated by the UPS under normal operating condition shall not exceed 78 dB measured five (5) feet from the front of the cabinet surface.

The requirements of each sub-system of UPS are detailed below:

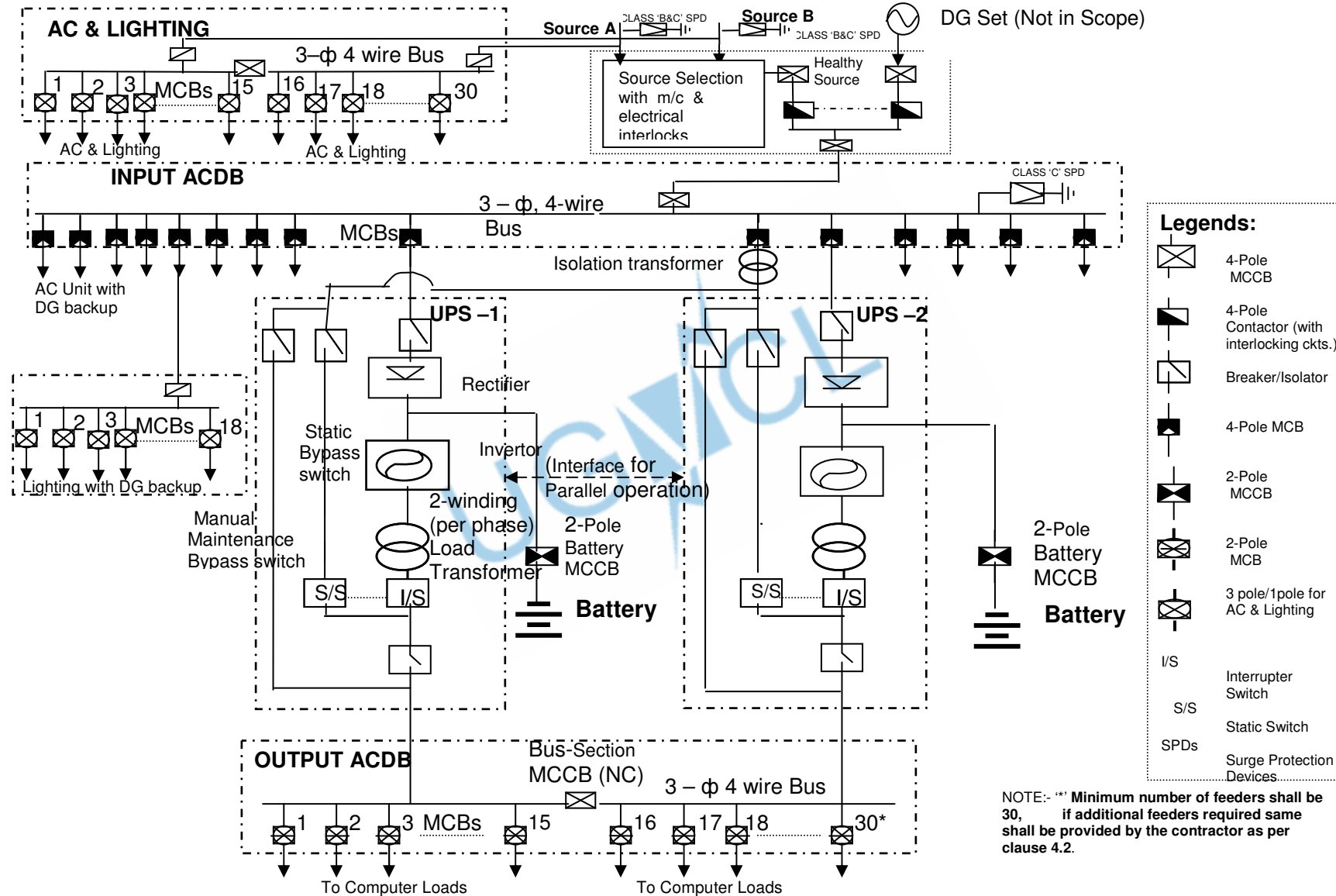
4.1.4 Rectifier/Charger Units

Each rectifier/charger unit output voltage shall be regulated to match the characteristics of the batteries and inverter. The rectifiers/chargers shall provide voltage regulated DC power to the invertors while also charging and maintaining the batteries at full capacity.

The rectifier/charger units shall have the following characteristics:

- a) Input Voltage and frequency characteristics as per clause 4.1.3 above.
- b) Input current limit of 125 percent of the nominal full load input current
- c) Maximum input current total harmonic distortion of 5 percent at nominal input voltage and under full load.
- d) The output shall be current limited to protect the rectifier/charger unit circuitry and to prevent the batteries from over-charging.
- e) Capacity to recharge the batteries to 90% of its capacity (from fully discharged state i.e. ECV of 1.75) within 8 hours while carrying full load.
- f) Automatic equalizing after partial discharge of the batteries.
- g) Temperature dependent battery charging with temperature sensing probes mounted on the battery banks.
- h) Automatic float cum boost charging feature.

FIG. 4-1 : CONCEPTUAL AUXILIARY POWER SUPPLY SYSTEM CONFIGURATION



4.1.5 Invertors

The invertors shall normally operate in synchronism with the mains AC power source. Upon loss of the mains AC power source or its frequency deviating beyond a preset range, the invertors shall revert to their own internal frequency standard. When the mains AC source returns to normal, the invertors shall return to synchronized operation with the mains AC source. Such reversal of operation of invertors from synchronous to free running mode and vice-versa shall not introduce any distortion or interruption to the connected loads. A suitable dead band for frequency may be provided to avoid unnecessary frequent reversal of inverter operation between free running mode and synchronised mode under fluctuating frequency conditions.

The invertors shall have the following characteristics:

- (a) Inverter unit shall be based on Pulse Width modulation (PWM) technique.
 - (b) The nominal output voltage shall be 415 Volt $\pm 1\%$, 3-phase, 4-wire AC up to rated load.
 - (c) The transient voltage response shall not exceed 4% for the first half-cycle recovering to 1% within ten cycles for a 100 percent step load application or removal.
 - (d) The free running frequency shall not deviate by more than $\pm 0.1\%$ for the rated frequency of 50 Hz.
 - (e) The invertors shall be synchronized to the main AC source unless that source deviates from 50 Hz by more than 1% (adjustable to 1/2/3/4/5 %).
 - (f) The output voltage harmonic distortion shall not exceed 5% RMS and no single harmonic component shall exceed 3%.
 - (g) The invertors shall be capable of resistive load operation & deliver at least 80% of the nominal capacity at the rated power factor and be capable of operation with loads ranging from the rated through unity power factor. Inverter shall also accept 100% load at crest factor of at least 3:1 for Switching Mode Power Supply (SMPS) load of computer system equipments without de-rating.
 - (h) The invertors shall provide protection logic to automatically shut down and isolate itself from the load when the battery voltage drops below a preset voltage.
 - (i) The invertors shall provide interrupter switch to isolate the unit from the load on failure of the unit. The interrupter switch shall be rated to carry full continuous load and to interrupt the inverter under full fault load.
 - (j) The invertors shall be capable of supporting a start-up surge or overload of 150 percent of rated output for up to 60 seconds.
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In case the inverter subsystem does not include an internal load transformer, an external load transformer of delta-wye configuration, 3-phase, 50Hz, 415 V AC, suitable for the inverter shall be provided.

4.1.6 Static Bypass Switches

Each UPS system shall include static bypass switch to facilitate automatic transfer of loads from the inverter sub-system output to bypass AC source through isolation transformer. Isolation transformer shall be rated for at least two times the rating of single UPS sub system. However, in case of parallel-redundant UPS systems, the transfer to Static bypass must occur only when the inverters of both the UPS systems have failed.

The transfer to Static Bypass from the inverter shall take place under the following fault conditions:

- (a) The inverter load capacity is exceeded
- (b) An over- or under-voltage condition exist on the inverter output
- (c) Inverter failure.

The static bypass switches shall be high-speed devices rated to transfer and carry full rated load. The static bypass switches shall provide protection to prevent out of phase transfers. The switching speed of the static bypass switches shall be less than 1 millisecond. During the changeover, the output voltage should not fall below 205V A.C., 50Hz $\pm 5\%$, in order to avoid any disruption to computer load supply. An automatic transfer back to the inverter subsystem shall occur if the transfer from the inverter subsystem was caused by a temporary overload and the load has returned to normal or by a temporary over/under voltage condition on inverter output and the voltage has returned to normal.

The transfer back to the inverter subsystem, both automatic and manual, shall be inhibited under the following conditions:

- (a) The frequency of bypass AC source is outside the frequency band of $\pm 1\%$ of 50Hz (adjustable to 1/2/3/4/5 percent).
- (b) The inverter output voltage and frequency are beyond the preset range.
- (c) An overload exists.

4.1.7 Manual Maintenance Bypass Switches

Manual bypass switches are provided to facilitate maintenance of the UPS system and shall provide transfer of the connected load from one UPS output to the other UPS system. These switches shall be rated to transfer and carry continuous full rated load.

4.1.8 Batteries

UPS system shall have a set of storage batteries designed for continuous UPS application. The battery set shall have sufficient capacity to maintain output at full rated load for the specified backup duration after 8 hour charging. The backup duration of the

battery shall be as specified in the BOQ. The battery set shall be maintenance free VRLA type Batteries. The detailed requirement of batteries is given under clause 4.4

4.1.9 Battery Breaker for UPS system

A 2-pole MCCB of suitable rating shall be provided near the battery bank (at suitable location on the frame of the battery bank) to allow disconnection of the batteries from the rectifier/charger unit and inverter. This shall also provide over-current protection to the battery circuits.

4.1.10 UPS Control/Monitoring

The Contractor shall supply control panel to permit automatic & manual operation of UPS, display of associated alarms and indications pertaining to the UPS. In each UPS system, a local display of the following analog and status/alarm signals/indications as a minimum shall be included:

Analog signals for the following measurements:

- i. AC input voltage (to display each phase)
- ii. AC output voltage (to display each phase)
- iii. AC output current (to display each phase)
- iv. AC input mains Frequency
- v. AC UPS Output Frequency
- vi. DC voltage (battery subsystem)
- vii. DC current (battery subsystem)

Status/Alarms signals for the following indications :

- a) Parallel operation of inverters
- b) Inverters running in synchronised / free running mode.
- c) Battery Low voltage alarm (battery subsystem)
- d) Load on battery alarm
- e) Battery Circuit Breaker Open alarm
- f) Overload trip alarm
- g) High-temperature alarm
- h) Equipment failure alarm

For remote monitoring a wall mounted type panel consisting of audio visible alarm or PC based monitoring system shall be provided in the control room. For PC based monitoring system required computer hardware and software shall be provided by the contractor. The monitor of PC shall be 15" TFT type.

4.1.11 Internal Wiring

All internal wires shall be of stranded copper conductor, sized according to the current requirements with minimum insulation rating of 1100 VAC. Extra-flexible wire shall be used for all circuits mounted on door or swing panels within the UPS

4.1.12 Enclosures/Panels design

The UPS electronic equipment and associated circuitry & all devices shall be housed in a freestanding enclosures/panels. Modules and sub-assemblies shall be easily replaceable and maintainable. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The applicable degree of protection of enclosures shall be IP20 however, suitable protection shall be provided against vertical dripping of water drops. UPS shall be installed with the necessary base frame including anti-vibration pad. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for front & rear, sides, bottom and top covers shall be minimum 1.6 mm. For other requirement of enclosure/panel, clause 4.2.3.4 may be referred.

4.1.13 Equipment / Panel Earthing

Each enclosure shall include suitable signal & safety earth networks within the enclosure. The signal-earthing network shall be separate & terminated at a separate stud connection, isolated from safety earth network. Each earth network shall be a copper bus bar, braid or cable. The contractor shall connect safety and signal earths of each enclosure to the earth grid/earth riser through suitable 50X6 sq. mm. GI strips. For other requirement of enclosure/panel earthing, clause 4.2.3.5 may be referred.

4.1.14 External Power Connections

All breakers/switches shall be suitably rated to match the requirement of external power connections.

4.1.15 Testing of UPS

4.1.15.1 Type Test of UPS

The Contractor shall supply type tested UPS equipments. The Contractor shall submit the UPS type test reports of earlier conducted tests (including performance & EMC requirements) on the same make, model, type & rating as offered, as per IEC 62040 or equivalent EN/BS standards. For type testing requirements in addition to provisions of section 7 is also to be complied.

4.1.15.2 Factory Acceptance Test of UPS

A factory acceptance test shall be conducted on all the equipments and shall include, but not be limited to the following, appropriate to the equipment being tested:

- (a) Verification of all functional characteristics and requirements specified
 - (b) Voltage drop and transients generated during switching operations
 - (c) System efficiency tests
 - (d) Verification of all features and characteristics included in all the delivered equipments and also as per specification requirements.
 - (e) Inspection and verification of all construction, wiring, labelling,
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documentation, and completeness of the hardware

Before the start of factory testing, the Contractor shall verify that all change orders applicable to the equipment have been installed. As a part of the factory tests, unstructured testing shall be performed to allow Employer representatives to verify proper operation of the equipment under conditions not specifically tested in the above structured performance test. A minimum of 8 hours of the factory test period shall be reserved for unstructured testing. The Contractor's test representative shall be present and the Contractor's technical staff members shall be available for consultation with Employer personnel during unstructured test periods. All special test facilities used during the structured performance test shall be made available for Employer's use during unstructured testing.

The respective factory acceptance tests for UPS are listed in Table 4.1

4.1.16 Environmental Conditions

UPS & all other hardware and components shall be capable of continuous operation at rated load without failures in the following environmental conditions:

Temperature/humidity - Ambient temperature of 0° to 50°C and upto 95 percent humidity, non-condensing. However, air conditioned environment shall be provided for VRLA batteries.

Table 4.1 LIST OF FACTORY & SITE TESTS FOR UPS

Sl. No.	Test	Factory Acceptance Tests	Site Tests
1.	Interconnection Cable Check	√	√
2.	Light Load Test	√	
3.	UPS Auxiliary Devices Test	√	√
4.	A.C. input failure Test	√	√
5.	A.C. input return Test	√	√
6.	Simulation of parallel redundant UPS fault	√	
7.	Transfer Test	√	√
8.	Full Load Test	√	√
9.	UPS Efficiency test	√	
10.	Unbalanced Load test	√	
11.	Balanced Load test	√	
12.	Current division in parallel or parallel redundant UPS test	√	
13.	Rated stored energy time test (Battery test)		√
14.	Rated restored energy time test (Battery test)		√
15.	Battery ripple current test		√
16.	Overload capability test	√	
17.	Short circuit test	√	
18.	Short-circuit protection device test	√	
19.	Restart test	√	√

Sl. No.	Test	Factory Acceptance Tests	Site Tests
20.	Output Over voltage test	√	
21.	Periodic output voltage variation test	√	
22.	Frequency variation test	√	
23.	Harmonic Components test	√	
24.	Earth Fault test	√	
25.	On site ventilation test		√
26.	Audible noise test	√	
27.	Parameter/Configuration settings	√	√
28.	Phase Sequence Test	√	√
29.	Coordination and discrimination of Tripping of associated breakers (MCCB/MCBs) in upstream & down stream		√



4.2 AC DISTRIBUTION BOARDS

AC distribution boards shall be provided for UPS input and output power distribution. The distribution boards shall distribute power and provide protection against failures on feeder circuits, to the equipment. The Contractor shall be responsible for design, engineering, manufacturing, supply, storage, installation, cabling, testing & commissioning of AC distribution boards required for distribution of power. The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The phase to neutral input voltage shall be (Nominal 240V) varying from 190V to 265 V.

The Input ACDB will cater for the load requirements of DC power supply system, air-conditioning alarm system, fire protection alarm system, lighting loads and one spare of 20A minimum, in addition to UPS system load. The Output ACDB shall cater for only critical loads in the control centre. The number of feeders and their ratings in the output ACDB shall be decided during detail engineering. At least five spare feeders in the output panel shall be provided.

All MCCBs shall conform to IEC-60947-2 & IS 13947-2/IEC 947-2, IEC-60898 and IS 8828 and shall be of Four (4) Pole type of requisite rating. MCBs used for load feeders in output ACDB shall be of minimum curve B characteristics. The load feeders shall be coordinated with requirement of loads of computers and other loads.

4.2.1 Enclosures/Panels

The equipments of ACDBs shall be physically mounted in freestanding enclosures/panels. MCCBs and sub-assemblies shall be easily replaceable and maintainable. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The Contractor shall state the type, size and weight of all enclosures and indicate the proposed manner of installation. The applicable degree of protection of enclosures shall be at least IP21. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for front & rear, sides and top covers shall be minimum 1.6 mm. For wall mounted type of output ACDB the above requirements shall not be applicable.

4.2.2 Equipment/Panel Earthing & Surge Protection

Each enclosure shall include suitable safety earth networks as per clause 4.2.3.5. . Surge protection devices shall be installed in the input ACDB to provide adequate protection against current and voltage transients introduced on input AC due to load switching surges. These protection devices shall be in compliance with IEC- 61312, IEC- 61024 and VDE 0100-534 for following surges:

a) Low Voltage Surges (Class C)

Between	Requirement
R, Y, B & N	$I_n \geq 10 \text{ kA}, 8/20 \mu\text{S}$ for each phase
N & PE	$I_n \geq 20 \text{ kA}, 8/20 \mu\text{S}$

I_n = Value of Nominal Discharge Current.

4.2.3 CABLING REQUIREMENTS

The contractor shall supply, install and commission all power cables, control cables, network interface cables and associated hardware (lugs, glands, cable termination boxes etc.) as required for all equipment. The contractor shall be responsible for cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of owner supplied cables if any at contractor's equipment end including supply of suitable lugs, glands, terminal blocks & if necessary cable termination boxes etc. All cabling, wiring and interconnections shall be installed in accordance with the following requirements.

4.2.3.1 Power Cables

All external power cables shall be stranded aluminium/Copper conductor, armoured XLPE/PVC insulated and sheathed; 1100V grade as per IS 1554 Part-I. The conductor for the Neutral connection from UPS to Output ACDB shall be sized 1.8 times the size of the Phase conductors to take care of the non-linear loads. However, the cable between UPS & Battery bank shall be of copper conductor (armoured type).

4.2.3.2 Cable Identification

Each cable shall be identified at both ends, which indicates the cable number, and the near-end and far-end destination. All power cables shall have appropriate colour for identification of each phase/neutral/ground. Cable marking and labelling shall comply with the requirements of the applicable standards.

4.2.3.3 Cable and Hardware Installation

The Contractor shall be responsible for supplying, installing, and terminating all cables and associated hardware (lugs, glands, etc.), required to mechanically and electrically complete the installation of facilities for the project.

4.2.3.4 Enclosures/Panels design

Enclosures/panel shall be of freestanding type of design. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The enclosures shall not have doors that are wider than 80 cm and doors shall be hinged with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.5 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size and weight of all enclosures and indicate the proposed manner of installation.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in

multi-conductor cables shall be individually colour coded, and numbered at both ends within enclosures.

The enclosures shall be painted inside and outside. The finish colour of all enclosures shall be aesthetically pleasing and shall be approved by the owner. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.

Maintenance access to the hardware and wiring shall be through full height lockable doors.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch.

Each ACDB and equipment within ACDB enclosures shall be clearly labelled to identify the enclosure/equipment. All labelling shall be consistent with Contractor-supplied drawings.

4.2.3.5 Enclosure/Panel Earthing

Each enclosure shall include suitable earth networks within the enclosure. Earth network shall be a copper bus bar, braid or cable inside enclosures.

The safety earth network shall terminate at two/more studs for connecting with the earthing grid. Safety earthing cables between equipment and enclosure grounding bus bars shall be of minimum size of 6 mm², stranded copper conductors, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid.

For all enclosures requiring AC input power, the green earthing wire from the AC input shall be wired to the safety-earthing stud. The Contractor shall provide all required cabling between enclosures for earthing. The contractor shall connect safety and signal earths (as applicable) of each enclosure to the nearest earth grid/earth riser through suitable 50X6 sq. mm. GI/25x3 Cu strips. The contractor may use the existing grid wherever available. In case the suitable earthing grid is not available the same shall be made by the contractor.

The signal earthing network shall terminate at a separate stud connection, isolated from safety ground. The stud connection shall be sized for an external earthing cable equipped with a suitable lug.

All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

4.3 DC POWER SUPPLY SYSTEM

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments, RTUs and other associated equipment located at indoor, i.e. at the substations, the control centers and customer care system. The AC input to the ACDB shall be provided from the ACDB described under clause 4.2 at control center. At other locations the AC input to the DCPS system shall be single phase AC which will be provided from the existing system. At these locations the class B & C level of surge protection (between phase-neutral and neutral – protective earth) as specified under and conforming to IEC 61312, IEC 61024 and VDE 0100-534 shall be installed in the DCPS system.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input AC due to load switching and low energy lightning surges. These protection devices shall be in compliance with IEC- 61312, IEC- 61024 and VDE 0100-534 for following surges:

a) Lightning Electromagnetic impulse and other High Surges (Class B):

Between	Requirement
Ph & N	$I_{imp} \geq 50 \text{ kA}, 10/350 \mu\text{S}$ for each phase
N & PE	$I_{imp} \geq 100 \text{ kA}, 10/350 \mu\text{S}$
I_{imp} = Value of Lightning Impulse Current	

b) Low Voltage Surges (Class C)

Between	Requirement
Ph & N	$I_n \geq 10 \text{ kA}, 8/20 \mu\text{S}$ for each phase
N & PE	$I_n \geq 20 \text{ kA}, 8/20 \mu\text{S}$
I_n = Value of Nominal Discharge Current.	

4.3.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed indoors and shall be provided with IP21 panels. The System shall consist of the following:

- (a) SMPS modules
- (b) Controller module to control and monitor all DCPS modules.

The number and rating of SMPS modules shall be provided as per the Employer's requirements stipulated in the BOQ. The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output. The size of fuses, MCBs, switch, bus etc shall be suitable for the ultimate capacity.

The system shall be sufficiently flexible to serve any load depending on manufacturer's design, rating and number of SMPS modules used in panel and system configuration. To cater for higher load requirements, same type of SMPS modules mounted in the same rack or different racks shall be capable of working in parallel load sharing arrangement. The DCPS system shall be suitable for operation from single phase A.C. mains.

4.3.2 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters not specified in this specification. The component parts of the equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. The component shall conform to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same. Conceptual diagram for DCPS is shown in figure 4-2.

The DCPS shall be suitable for operation at ambient temperature of 0-50 deg and relative humidities up to 95 %.

4.3.3 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS 1554 or equivalent international standard.

All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be suitably secured.

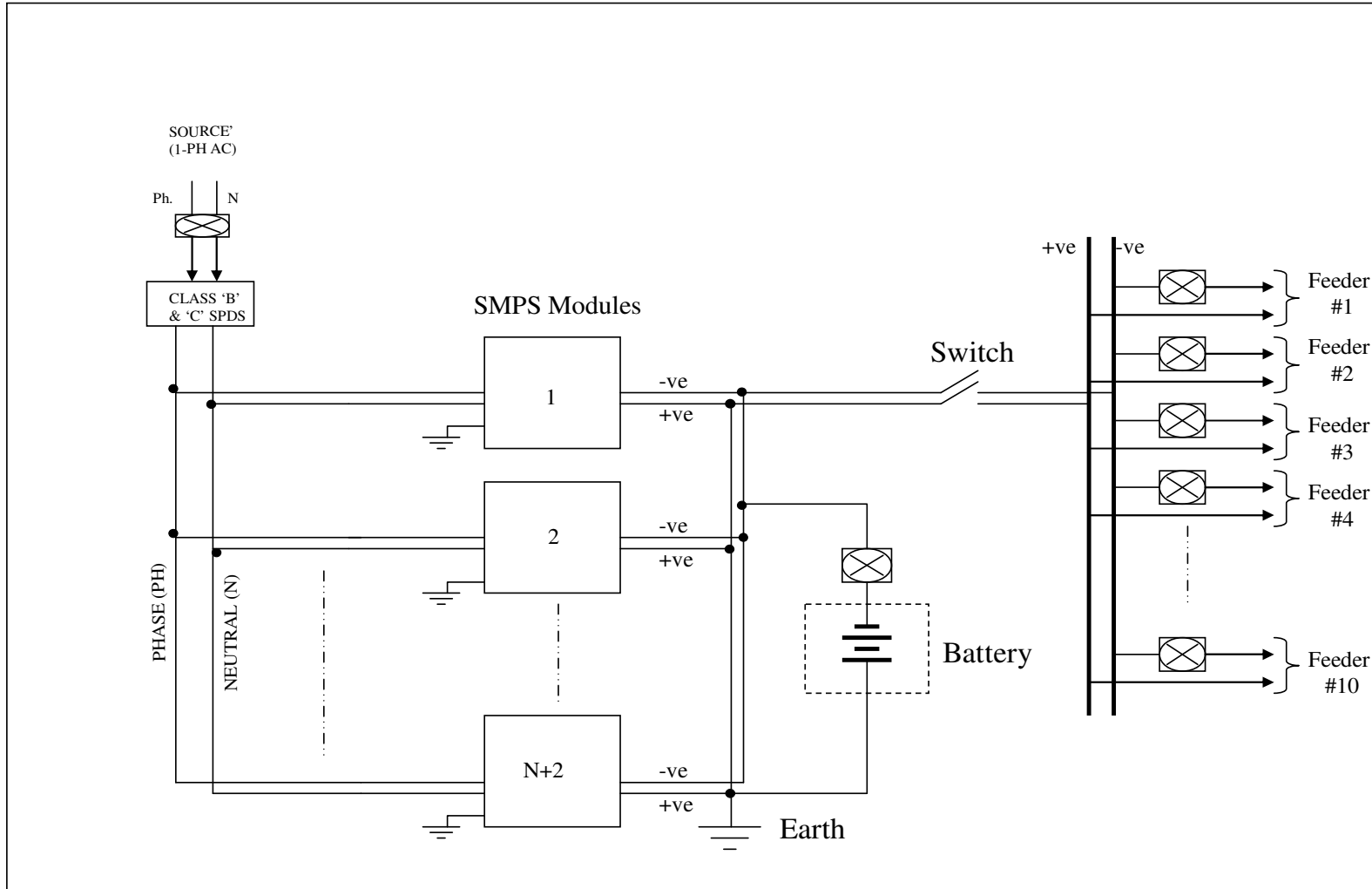
4.3.4 Bus Bars

High conductivity Cu bus bar shall be provided and shall be sized to take care of the current of ultimate DCPS system capacity for which it is designed. However, it shall not be less than 25mm X 5mm.

4.3.5 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door shall be connected to the panel with braided Cu at two points at least.

FIG. 4-2 : CONCEPTUAL CONFIGURATION OF DC POWER SUPPLY (DCPS) SYSTEM



4.3.6 Finish and Painting

The finish of Steel/Aluminum alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour scheme for panel, Door and Modules shall be decided during detailed engineering.

4.3.7 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labeling the inter panel cables and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

4.3.8 Name Plate

A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each panel /module and contain at least the following information :

- (a) Type of the Unit / Model No
- (b) Manufacturer's Name and identification
- (c) Unit serial No
- (d) Year of manufacture
- (e) Input voltage and phase
- (f) Output Voltage and Current

4.3.9 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

4.3.10 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in Section 4.3.1 General Technical Requirements. The control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The number of SMPS modules to be provided in the DCPS system shall be provided in N+2 configuration, where N is the number of SMPS modules to meet the battery charging current (10% of C₁₀ AH Capacity) of the offered battery plus the load requirement stipulated in the BOQ. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

It shall be possible to easily mount/remove the modules from the front side of the panel. The SMPS modules/SMPS module sub-racks shall be designed to slide into the panels and fixed securely by a suitable mechanical arrangement.

4.3.11 Constructional Features of Panel

Panel (Enclosure) shall be freestanding type of design. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The enclosures shall not have doors that are wider than 80 cm and doors shall be hinged with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.5 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size, and weight of all enclosures and indicate the proposed manner of installation.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi conductor cables shall be individually colour coded, and numbered at both ends within enclosures.

The enclosures shall be painted inside and outside. The finish colour of all enclosures shall be an aesthetically pleasing and shall be approved by the owner. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.

Maintenance access to the hardware and wiring shall be through lockable, full height, from doors.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The manufacturer so as to ensure the uninterrupted use of the equipment shall do proper thermal engineering of hardware design. The Panel shall be designed to allow cooling preferably by natural convection. The Bidders shall submit detail design of proposed Panel/enclosure and heat dissipation calculations during detailed engineering. Forced cooling is permitted (DC Fans are permitted in the Panel or SMPS module) for equipment mounted indoors (buildings/rooms/shelters). If cooling is provided at Panel level it shall be provided with additional fan with facility for manual switch over. Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. The required individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

4.3.12 Electrical Requirements :

AC input supply: The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The input voltage shall be single phase (Nominal 240V) varying from 190V to 265V.

There shall be an automatic arrangement for shutting off of the SMPS module whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The SMPS module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the SMPS. A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation.

4.3.13 DC output Characteristics of Modules

The module shall be capable of operating in “Auto Float-cum-Boost Charge” mode depending on the condition of the battery sets being sensed by the Control unit.

- (a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of -48 to $-56V$ either at the module or may be set from the common controller configuration. Further, the prescribed float voltage setting shall be based on recommendations of the VRLA battery supplier.
- (b) In Boost charge mode SMPS shall supply battery & equipment current till terminal voltage reaches set value, which is normally $2.3V/cell$ ($55.2V$) or as recommended by the VRLA battery supplier & shall change over to constant voltage mode
- (c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

4.3.14 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -44.4 volts to -56 Volts.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

4.3.15 Soft/Slow Start Feature:

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

4.3.16 Voltage overshoot/Undershoot :

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS module.

- (a) The SMPS modules shall be designed to minimise DC output voltage

Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to $\pm 5\%$ of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.

- (b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.3.12 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to $\pm 5\%$ of its set voltage and return to steady state within 20ms.
- (c) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

4.3.17 Electrical Noise :

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise and ripple shall be as per relevant standards.

4.3.18 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within $\pm 10\%$ of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

4.3.19 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

4.3.19.1 DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds $-57V$ or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of $\pm 0.25V$ is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

4.3.20 Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows:

1. Live AC input line
2. Control Circuit

All fuses/circuit breaker used shall be suitably fault rated.

4.3.21 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 4.3.12 for Electrical Requirements.

4.3.22 Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit as per clause 4.3.14 Current Limiting (Voltage Droop).

4.3.23 Alarms and indicating lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each SMPS module for detection of SMPS module failure.

4.3.24 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as owners ACDB, Telecom and other associated equipments and alarm cables. All the termination points shall be easily accessible from front and top. AC and DC terminals shall be separated by physical barriers to ensure safety. All the terminals except AC earth shall be electrically isolated.

4.3.25 DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the battery from the load shall create an alarm. DC distribution shall be provided with adequate no of feeders (with three no of spare) with appropriate MCBs (6 Amp thru 32 Amp) for termination of the loads. Actual rating of the MCBs and no of feeders shall be finalized during the detail engineering.

DC distribution may be done either on wall mounted panel or on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and -ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

4.3.26 Power Cables

All power cables shall be stranded copper conductor XLPE/PVC insulated and PVC

sheathed, single core/two core/three core/four core, 1100V grade as per IS 1554 Part-I.

4.3.27 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm² stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

4.3.28 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate :

Functional Indications for local monitoring:

- a) Mains available (not mandatory if provided at module level)
- b) DCPS/SMPSs in Float
- c) DCPS/SMPSs in Charge Mode

Alarm Indication for local monitoring:

- a) Load Voltage High /Low
- b) DCPS module/SMPS fail
- c) Mains out of range
- d) System Over Load
- e) Mains "ON"/Battery Discharge
- f) Temp. Compensation fail
- g) Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and $\pm 5V$ for AC voltage

Alarm Indication for remote monitoring:

- a) Input AC mains supply fail alarm
- b) Battery low voltage (Pre cut off) alarm
- c) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through RTU and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for termination to RTU.

4.3.29 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependant charge characteristics. The output voltage of

the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage.

4.3.30 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

- (a) Input AC voltage.
- (b) Out put DC voltage
- (c) Output DC current of charger
- (d) Battery current
- (e) Load current.

The Digital display of meters or display unit shall be with minimum 3¹/₂ digital display of height 12mm and shall have an accuracy 1.5% or better.

4.3.31 Type Testing of DCPS

The contractor shall supply DCPS System, which was already type tested. The test reports for immunity, Emission and surge must be in accordance with relevant IEC/CISPR standards shall be submitted . The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests. For type testing requirements in addition to provisions of this section 7 is also to be complied.

Type Tests on DCPS

- 1 Surge immunity (Level 4- as per IEC 61000-4-5)
- 2 Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4)
- 3 Electrostatic Discharge (Level 4 – as per IEC 61000-4-2)
- 4 Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3)
- 5 Conducted disturbances induced by radio-frequency field (Level 3 – as per IEC 61000-4-6)
- 6 Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10)
- 7 Voltage dips, short interruptions and voltage variations (Level 2 – as per IEC 61000-4-11)
- 8 Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11)
- 9 Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11)
- 10 Verification of Protection class (IP 21) for enclosure
- 11 Safety Tests (as per IEC 60950)
- 12 Burn in test for 72 hours at maximum operating temperature

4.3.32 Factory/Site Testing of DCPS

The factory/site tests to be carried out on DCPS system/module in the factory and site are listed respectively in Table below. The manufacturer shall conduct routine tests on all the systems/modules and submit the report before offering for FAT. The routine tests shall include atleast the tests mentioned under FAT.

Sl.No.	Test	FAT	SAT
Tests on DCPS System			
1.	Mechanical & Visual Check Tests	√	√
2.	Insulation Test.	√	
3.	High Voltage Withstand Test	√	
4.	Switch On Test	√	√
5.	DCPS Low voltage & High voltage limits check Test	√*	√
6.	Pre-alarm test for Battery Voltage Low	√*	√
7.	Battery Low Voltage Disconnect Level Test	√*	√
8.	AC Input Low and High voltage limits check Test	√*	
9.	Rectifier Fail Alarm Test	√*	√
10.	Voltage Regulation Test	√*	√
11.	Current Sharing Test	√*	
12.	Total Output Power Test	√*	√
13.	Hot Plug In Test	√*	√
14.	Calibration & Parameter settings	√*	√
15.	Automatic Float cum Boost Charge Mode Change Over Test	√*	√
16.	Battery Path Current Limiting Test	√*	√
17.	Battery Charging and full load Current Test	√*	√
18.	Battery Temperature Compensation Test	√*	
19.	Total Harmonic distortion Test	√*	
20.	Burn in Test for 8 hours at max operating temperature	√*	
Tests on SMPS module			
21	Mechanical & Visual Check Test	√*	
22	Module-On Test	√*	
23	Input low/high voltage cut-off test	√*	
24	Voltage Droop Test	√*	
25	Voltage Regulation Test	√*	
26	Power Output & Current Limit Test	√*	
27	DC High Voltage Test	√*	
28	O/P Voltage Ripple Test	√*	
29	Psophometric Noise Test	√*	
30	Efficiency Test	√*	
31	Power Factor	√*	
32.	Input Current Limit	√*	

Sl.No.	Test	FAT	SAT
33.	Input AC Frequency Range Test	√*	
34.	Rectifier Dynamic Response	√*	
35.	Output Short Circuit Test	√*	
36.	Hold up Time Test	√*	

Note* : These tests (Sl. No. 5-36) shall be conducted on 10% samples of the offered batch and other tests (Sl. No 1-4) shall be conducted on each equipment during the FAT.



4.4 BATTERY REQUIREMENTS

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery for UPS & DCPS system. Each battery set shall have sufficient capacity to maintain output at full rated load for duration as defined in **BOQ**. The Bidder shall furnish detailed battery sizing calculations along with all arrangements and supporting structures, for UPS and DCPS system being proposed, along with the bid. In all cases the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge.

The contractor supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document.

Battery sizing calculation for UPS shall be done considering the actual charging achieved in eight hours i.e. in case 100% charging is not achieved in eight hours the Ah of the battery shall be enhanced by the ratio of charging actually achieved in eight hours.

4.4.1 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections. It shall be possible to easily replace any cell of the battery at site in normal working condition.

4.4.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28%. The porosity of the container shall be such that so as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such that so as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

4.4.3 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

4.4.4 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

4.4.5 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-seal able and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

4.4.6 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

4.4.7 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

4.4.8 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

4.4.9 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

4.4.10 Capacity Requirements

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27°C) before any of the cells in the battery bank reaches 1.85V/cell.

All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell $\pm 0.05V$ band.

The capacity (corrected at 27°C) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

- (a) After Six minutes of discharge : 1.98V/cell
- (b) After Six hours of discharge : 1.92V/cell
- (c) After 8 hours of discharge : 1.85V/cell
- (d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere-hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%.

4.4.11 Expected Battery Life

The battery shall be capable of giving more than 1200 charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected operational life of 5 years at normal operating conditions or 1200 charge / discharge cycles (whichever is early).

4.4.12 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

- a. Torque wrench.
- b. Tool for opening /closing of pressure regulation valve of battery.
- c. Hand held digital Multimeter for measurement of resistance, AC/DC voltages.

4.4.13 Testing of Battery

The contractor shall supply type tested battery as required for DCPS and UPS system. The Contractor shall submit the Battery type test reports of earlier conducted tests on the same make, model, type & rating as offered as per the IEC 60896 or equivalent IS/EN/BS standards . These Type test reports shall be submitted for the highest rating battery to be supplied under the contract. For type testing requirements in addition to provisions of this section 7 is also to be complied. The tests mentioned in the Table 4.2 shall be conducted on the battery at site and factory.

TABLE 4.2 LIST OF FACTORY & SITE TESTS FOR BATTERY

S. No.	Test	Factory Tests	Site Tests
1.	Physical Verification	√	√
2.	C/10 Capacity test on the cell	√	
3.	8 Hrs. Charge and 30 minutes (duration as specified) discharge test at full rated load for UPS.		√

4.5 Testing Requirements

The requirements for type tests, factory acceptance tests and field acceptance testing have been specified under the respective clauses. After completion of field acceptance testing the auxiliary power supply system shall be put under availability test for fifteen (15) days. Availability test shall be carried out by the employer/owner. During the availability test the APS shall be used as required to be used for rest of the life. In case of any failure or mal-operation during this period the contractor shall take all necessary action to rectify the problems. The APS shall be accepted only after rectification of the problems by the contractor in a manner acceptable to the employer.

4.6 2KVA UPS

Two KVA UPS shall be supplied for bill collection centres as per the quantity specified in the BOQ. The technical particulars of these UPS shall be as mentioned below:

Technical Specification for 2 KVA (1.6 KW) UPS

	Parameter	Requirements
INPUT	Voltage	230±15%V AC, 50Hz, Single phase
	Frequency	50 ± 5% Hz
OUTPUT	Power	2 kVA / 1.6 kW (at 0.8 pf)
	Voltage	230V AC Single phase (±1 %)

	Parameter	Requirements
	Frequency	50 Hz & $\pm 0.2\%$ (Free Running)
	Regulation	$\pm 1\%$
	Transient Response	$\pm 5\%$ for 100% load change and recovers to normal within 10 milliseconds
	Waveform	Pure Sine wave, THD <2% (linear load)
	Short term overload	110% for 15 minutes and 150% for 10 seconds
	Efficiency (Peak)	>90%
	Supported load pf	0.6-unity
	Change Over	Transfer time (in Sync Mode) less than 5 msec
BATTERY	Type	SMF/lead Acid tubular
	Backup time	4 hours
	Recharge Time	Maximum 12 hours*
	Life	Minimum 3 years (SMF)/ 8 years(LATB)
GENERAL	LED Indicators	Mains ON, Converter / Inverter faults, O/P high/low, Bypass mode, Inverter ON/OFF
	Audible Alarm	Main Failure, Low Battery, Overload
	Isolation	UPS output isolated from Mains Input
	Protection class	IP-21
	Temperature	0-45° C (Battery shall be sized at an average temp. of 27 deg C.)
	Humidity	Upto 95% RH (Non condensing)

* **Note** : Battery shall be sized to deliver rated load for specified duration after charging for 12 hours from fully discharged state of battery(1.75V for VRLA).

4.7 Documentation

The following specific document for items covered under this section shall be submitted which shall be in addition to the applicable general document required under section 7.

- Data Requirement Sheets (DRS)
- Battery sizing calculations
- Cable sizing calculations
- Inventory of the hardware
- Panel General arrangement drawing
- Panel Internal General Arrangement drawing indicating modules, major devices/components location etc.
- Installation drawings
- Schematic drawings
- Type Test reports
- FAT plan & procedure
- SAT plan & procedure
- External cable laying & termination schedule details
- Availability test plan & procedure

4.8 Mandatory Spares

List of mandatory spares for UPS, DCPS are mentioned in the BOQ