

**Section-05****DC Power Supply System****Requirements****Table of Content**

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## Section-05

### DC Power Supply System Requirements

In order to provide reliable power supply to communication equipment at various locations, 48 V DC Power Supply (DCPS) system is to be provided as a part of this project. This section describes the technical requirement of DC power supply & associated Battery.

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments. The required load (in Amps) for each location along with the Battery capacity is indicated in the Appendices. The rating of offered SMPS modules shall meet Employer's requirements of DCPS system as stipulated in the BoQ.

The DC Power supply system shall have a single DCPS system as per conceptual configuration diagram given in Fig.5-1, shall be supplied.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input mains 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:

It shall be provided with Class 'B' & 'C' type surge protection device. The device must be provided with Class B type lightning current arrester (Switching Type) with a discharge current capacity of at least 50 kA, 10/350  $\mu$ s, and Class C type surge arrester (linear device) as per IEC 61643-1. The blind spots shall be avoided in accordance to IEC 61312. The Class 'C' surge protection device should be pluggable type, equipped with features of thermal disconnection, & health indication and potential free contacts for surge arrestors connected between phase & neutral.

The surge protection device shall comply to IEC 61643.

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	
Rated input voltage of Class 'B' surge arrestors shall not be less than 320 V.	

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  $I_n \geq 20 \text{ kA}, 8/20$   
 $\mu S I_n =$  Value of Nominal Discharge Current.

Voltage rating of Class 'C' surge arrestors shall be minimum 320 V.

The Class 'B' & 'C' Surge protection devices shall work in tandem and in perfect co-ordination to give complete protection to the DCPS system against lightning and switching surges.

### 5.1 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 Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified in BoQ. 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 SMPS modules of DCPS system shall be suitable for operation from single phase A.C. mains/DG set supply. However, the input AC mains supply to DCPS system shall be 3-phase, 4 wire which shall be evenly distributed among all the offered SMPS modules.

#### 5.1.1 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 as applicable. 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.

#### 5.1.2 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.

### **5.1.3 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.

### **5.1.4 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, if provided shall be connected to the panel with braided Cu at two points at least.

### **5.1.5 Finish and Painting**

The finish of Steel/ Aluminium alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour code scheme for Panel & Door (if provided) shall be decided during detailed engineering.

### **5.1.6 Marking and Labelling of Cables**

The Contractor shall propose a scheme for marking and labelling the inter panel cables by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 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.

### **5.1.7 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) Specification Number

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

### **5.1.8 System and Panel Configuration**

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

#### **5.1.9 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 5.1. The Control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The SMPS modules shall be provided as per the load requirement stipulated in the Appendix, BOQ. The DCPS system shall comprise of N+2 Modules. In case of DCPS system having N=1, the SMPS shall comprise of N+1 modules. Here N refers to number of SMPS modules to meet the load requirements specified BOQ and battery charging current. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

Total current = load current + battery charging current

Where, battery charging current is equal to the 20 % AH of the battery supplied.

$$N = \frac{\text{Total Current}}{\text{Current rating of each SMPS module at 48 V}}$$

The Distribution/switching/Alarm unit shall be provided for the ultimate system capacity. All AC, DC or control/alarm cabling/wiring shall be pre-wired for the ultimate capacity so that mere plugging-in of SMPS module shall add to the DC power output.

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.

#### **5.1.10 Constructional Features of Panel**

Panel (Enclosure) shall be freestanding type of design, in case if specifically, it is not

mentioned in the relevant section. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). For the enclosures/panel, the front door (if provided) shall not be wider than 80 cm and rear door may be of hinged or removable type 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 1.6 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. The degree of protection of DCPS enclosures shall preferably be IP21, however in case no door is provided then the top of the enclosure/panel shall be fully covered except for proper ventilation and bus bar or cable entries.

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 by Halogen & Silicon free labels of polyamide ensuring scratch proof labelling with the use of solvent free ink & latest UV Technology making it environment friendly printing with a WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1 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 Employer. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.

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 Contractor 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.



### 5.1.11 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 as mentioned below:

**Field Site Application** – Three phase/4Wire (Nominal 415/240 V):  $415 + 10\% - 15\%$ . However, at site the voltage may vary from 160V to 300V (Ph-N). An Auto-Mains Changeover unit shall be provided for each field site DC power supply system. The Auto-Mains Changeover unit shall accept input from two AC sources and extend any one of the available healthy sources to the DC Power supply system.

The suitable HVD (High Voltage Disconnecter) Protection shall be provided at input of each DCPS system. This HVD protection shall protect the SMPS modules of DCPS system against the sustained over voltage at the input.

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.

### 5.1.12 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  $-56V$  or as per battery manufacturer recommendations 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 battery supplier.
- (b) In Boost charge mode, DCPS shall supply battery & equipment current till terminal voltage reaches set value, as recommended by the 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.

### 5.1.13 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS SMPS 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 or as per manufacturer's specified catalogue.



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.

#### **5.1.14 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.

#### **5.1.15 Voltage Overshoot/Undershoot**

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

- (a) The SMPS modules shall be designed to minimize 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 5.1.11 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.

#### **5.1.16 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 (e.m.f weighted at 800Hz) with battery connected across the output should be within 2 mV at full load at nominal input AC supply. For test purposes, this shall be taken as equivalent to 4mV when the battery is not connected and in accordance to ITU-T Rec. O.41.

Voltage at the output of the Rectifier (SMPS) module, without battery connected, shall not exceed 300 mV at the switching frequency measured by an Oscilloscope of 50/60 MHz bandwidth (Typical).

#### **5.1.17 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.

#### **5.1.18 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.

#### **5.1.19 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.  
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.

#### **5.1.20 AC Under/Over Voltage Protection**

AC input Under/Over voltage protection shall be provided as per clause 5.1.11 for Electrical Requirements. The DC side of the SMPS should also be provided with surge protection device to protect the SMPS in case of transients being generated by the loads or due to induction in the DC line from the AC line running parallel together. The Surge protection device should be able to discharge a current of at least 10 kA of 8/20  $\mu s$  (Class 'C' surge arrestor), pluggable and should have indication to show its health to facilitate the replacement on fault condition.

### **5.1.21 Over Load/Short Circuit Protection**

The SMPS shall be protected for Over load/Short circuit as per clause 5.1.13 Current Limiting (Voltage Droop).

### **5.1.22 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.

### **5.1.23 Termination**

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as Employers 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.

### **5.1.24 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 appropriate MCBs (6 Amp thru 32 Amp) for termination of the loads. Actual rating of the MCBs shall be finalized during the detail engineering. The no. of feeders shall be minimum 10 (ten) nos.

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.

### **5.1.25 Earthing Cables**

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm<sup>2</sup> 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.

### **5.1.26 Alarms**

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

Functional Indications for local monitoring:

- I. Mains available
- II. DCPS/SMPs in Float charge Mode
- III. DCPS/SMPs in Boost 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) 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 communication equipments 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 interfacing purpose.

### 5.1.27 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 LCD based display unit shall be with minimum  $3\frac{1}{2}$  digital display of height 12mm and shall have accuracy 1.5% or better.

### 5.2 Cabling & Enclosure 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 feeder cables 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.

### **5.2.1 Power Cables**

All external power cables shall be stranded Aluminum conductor, armoured XLPE/PVC insulated and sheathed, 1100V grade as per IS-7098 Part-I /IS 1554 Part-I.

### **5.2.2 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 minimum size 6 sq. mm, stranded copper conductors, rated at 300 volts. All hinged doors (if provided) 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 Employer provided nearest earth grid/earth riser through suitable 50X6 sq. mm. GI strips or suitably sized copper cable.

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.

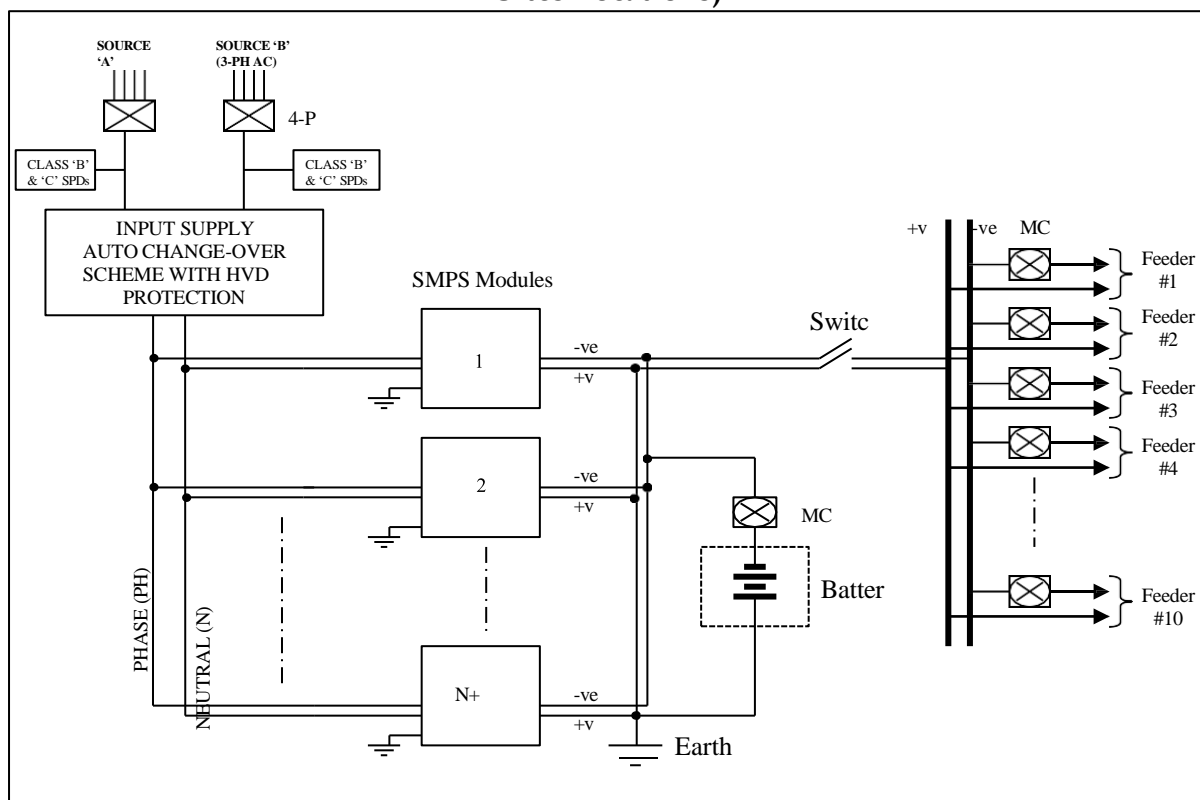
All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

### **5.3 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 (3mV/cell, 24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. A tolerance of +/- 5mV may be acceptable over the specified rate of 72 mV/degree C. 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. The nominal distance between the battery & DCPS system may be 20 metres. The Contractor shall provide the necessary sensor and cord for the purpose with DCPS system to sense the Battery temperature.

**FIG. 5-1 : CONCEPTUAL CONFIGURATION OF DC POWER SUPPLY (DCPS) SYSTEM (For Field Sites Locations)**



## 5.4 Battery Requirements

### 5.4.1 Valve Regulated Lead Acid (VRLA) maintenance free Battery

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery. Each battery set shall have sufficient capacity to maintain output at full rated load as indicated in BOQ. The battery shall be capable of being recharged to 90% State of Charge (SOC) from the fully discharged condition (1.75V/cell) within 10 hrs. 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 supplier, 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 bidding documents.

#### 5.4.1.1 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.



#### **5.4.1.2 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 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 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.

#### **5.4.1.3 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.

#### **5.4.1.4 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.

#### **5.4.1.5 Pressure Regulation Valve**

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-sealable 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.

#### **5.4.1.6 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.

#### **5.4.1.7 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.

#### **5.4.1.8 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.

#### **5.4.1.9 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.

### **5.5 Capacity Requirements**

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27°Celsius) 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°Celsius) 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  $\pm 0.05V$  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%.

### **5.6 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).

### **5.7 Routine Maintenance of Battery system**

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

- a. Torque wrench.
- b. Tool for opening /closing of pressure regulation valve of battery.

### **5.8 Testing requirements**

The Contractor shall submit type test reports for the battery for the same make, model & rating as offered as per the IEC 60896 or equivalent IS/EN/BS/TEC standards. In the event, the type test reports for exact rating is not available, the Contractor shall submit type test reports for higher rating Battery.

----- **End of this Section** -----