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| ISO 9001:2015                                          | Document No :<br>RDSO/SPN/165/2023 | Ver.: 4.0 | Date Effective: 20.06.2024 |
| DOCUMENTTITLE:SMPS based Integrated Power Supply (IPS) |                                    |           |                            |



## RESEARCH DESIGNS & STANDARDS ORGANIZATION

ManakNagar,Lucknow-226011

### SIGNAL& TELECOM DIRECTORATE

# SMPS BASED INTEGRATED POWER SUPPLY (IPS)

**Number of Pages: 56**

Specification no:RDSO/SPN/165/2023

**VERSION 4.0 with Amendment 1**

|                           |                      |                                |              |
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| DOCUMENT DATA SHEET                                                                                                           |  |                           |
|-------------------------------------------------------------------------------------------------------------------------------|--|---------------------------|
| Designation<br><br><b>RDSO/SPN/165/2023</b>                                                                                   |  | Version<br><br>4.0 Amdt.1 |
| Title of Document<br><br><b>SMPS based Integrated Power Supply (IPS)</b>                                                      |  |                           |
| Authors:<br><br>Name: Shri M.M Srivastava<br>Designation: <b>Director / Signal-IV</b>                                         |  |                           |
| Approved by:<br>Name: Shri <b>Suresh Kumar</b><br>Designation: <b>Principal Executive Director Signal &amp; Telecom, RDSO</b> |  |                           |
| Abstract<br><br>This document defines specification of SMPS based Integrated Power Supply (IPS) for Railway Signalling        |  |                           |

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### DOCUMENT CONTROL SHEET

| <b>Name</b>                                         | <b>Organization</b> | <b>Function</b>            | <b>Level</b>    |
|-----------------------------------------------------|---------------------|----------------------------|-----------------|
| <b>Shri Suresh Kumar<br/>PED/ S &amp;T Dte.</b>     | <b>RDSO</b>         | <b>Approving Authority</b> | <b>Approve</b>  |
| <b>Shri M. M. Srivastava<br/>Director/Signal-IV</b> | <b>RDSO</b>         | <b>Member</b>              | <b>Review</b>   |
| <b>Shri D.K Rawat DD/Lab Signal</b>                 | <b>RDSO</b>         | <b>Member</b>              | <b>Checking</b> |
| <b>Shri A. K. Kushwaha<br/>SSE/Signal</b>           | <b>RDSO</b>         | <b>Member</b>              | <b>Prepare</b>  |
| <b>Shri A. P. Singh<br/>JE/Signal</b>               | <b>RDSO</b>         | <b>Member</b>              | <b>Prepare</b>  |

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### **AMENDMENTS**

| Version     | Chapter/ Annexes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Amendments                              | Issue date       |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------|
| Ver.1.0     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | First issue<br>RDSO/SPN /165/2000       | January<br>2000  |
| Amendment 1 | Certain Clauses modified/amended/included for typographical errors, regrouping/inclusion of tests and other technological requirements etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                         | November<br>2000 |
| Amendment 2 | Clause 4.27 4.27.1 and 5.1.25 included/modified for incorporating provisions for lightning & surge devices and battery charging                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Modified / added.                       | April 2002       |
| Ver. 2.0    | (i) Clause 2.1, 3.3, 3.4, 3.5, 3.7, 4.5, 4.21, 5.1.1, 5.4.10 included/amended in view of the approval of RB on the recommendations of 77 <sup>th</sup> SSC.<br><br>(ii) Clause 2.3, 3.6, 3.9.2, 3.10.1, 3.14, 4.1, 4.25, 4.30, 5.1.4, 5.1.19, 5.1.24.3, 5.2.4, 5.3.24, 5.4.8, 5.4.12, 8.4 included / amended in view of the field problems and RB approval on recommendation of 9 <sup>th</sup> MSG.<br><br>(iii) Clause 4.12, 4.22, 4.28, 4.29, 5.1.6, 5.1.16, 5.1.17, 5.1.28.6, 5.2.15, 5.4.13, 5.4.17, 5.5.26, 6.0, 5.6.3, 5.7.2, 5.8.3, 10 modified/included for typographical errors / re-grouping / inclusion of various tests, incorporating provisions of manuals and up-gradation of technology. | Revision and issue<br>RDSO/SPN/165/2004 | June 2004        |
| Amendment 1 | Nomenclature for Alarms and indications in clause 4.1.23.1, 4.2.4.1, 4.2.4.2, 4.3.9, 4.5.5, 4.6.13, 4.8.1 has been standardized.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Modified                                | March 2005       |
| Amendment 2 | Severities for Change in Temperature cycle, Dry heat & Cold test (Clause 10.7.1) has been modified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Modified                                | March 2005       |
| Amendment 3 | Cl.No. 3.1.5, 3.2.2, 3.2.3, 4.1.16, 4.3.8, 4.3.14, 9.2(f), 9.3.1(j), 10.7.1 & Annexure 1 (SN 3) has been modified to increase the system reliability.<br>New clause 3.3.16 has been added to provide ventilation for individual                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Modified/Added/<br>Deleted              | May 2005         |

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|             | modules.<br>Clause 9.2 has been deleted.                                                                                                                                                                                                                                              |                                                                   |             |
| Amendment 4 | Clause 2.1, 2.2.4, 3.3.1, 3.3.4, 3.12.1, 3.13.2, 3.14, 4.5.7, 4.8.1, 6.9 & 10.2 modified for renumbering of Annexures, design improvement in DC-DC Converter and incorporation of version control.                                                                                    | Modified/Added                                                    | July 2005   |
| Amendment 5 | Cl. 3.12 related to Class B,C & D type Lightning & Surge Protection modified                                                                                                                                                                                                          | Modified                                                          | Jan 2006    |
| Ver. 3.0    | --                                                                                                                                                                                                                                                                                    | Modified and issued as<br>RDSO/SPN/165/2012.                      | 10.02. 2012 |
| Ver. 4.0    | All clauses rearranged/ renumbered & regrouped. A new clause 3.20 added for remote monitoring. Clause no. 2.2.1 deleted and corresponding Annexures modified/added.                                                                                                                   | Revision and issued as<br>RDSO/SPN/165/2023                       | 23.09.2023  |
| Amendment 1 | Clauses no. 3.4.1.13, 3.9.5.1, 3.12.1, 3.20.1, 3.22.7.2, 4.5.1, Annex-III A, Annex-V & Annex-VI modified/amended for typographical errors. and effective date extended upto 22.12.2023 from 23.09.2023 as per approval of PED/S&T on file no.SIG0IPS(PSM)/1/2020 on dated 22.09.2023. | Effective date extended with correction of<br>Typographical error | 22.12.2023  |
|             | Effective date extended upto 15.03.2024 from 23.09.2023 as per approval of PED/S&T on file no.SIG0IPS (PSM)/1/2020 on dated 22.12.2023.                                                                                                                                               | Effective date extension                                          | 15.03.2024  |
|             | Effective date extended upto 15.05.2024 from 15.03.2024 as per approval of PED/S&T on file no.SIG0IPS (PSM)/1/2020 on dated 14.03.2024.                                                                                                                                               | Effective date extension                                          | 15.05.2024  |
|             | Effective date extended upto 20.06.2024 from 15.05.2024 and Clauses no. 3.17.1, 3.21.6(i) 3.22.6.1(iii), 3.22.7.1, 3.22.7.3 & 4.1.1 modified/amended for typographical errors & request of firms and as per approval of PED/S&T on file no.SIG0IPS (PSM)/1/2020 on dated 16.05.2024   | Effective date extension                                          | 20.06.2024  |

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### **ABBREVIATIONS USED**

| <b>Abbreviation</b> | <b>Detail</b>                                              |
|---------------------|------------------------------------------------------------|
| AFTC                | Audio Frequency Track Circuit                              |
| AVR                 | Automatic Voltage Regulator                                |
| AMF Panel           | Auto Mains Failure Panel                                   |
| ASM                 | Assistant Station Master                                   |
| AFDS                | Automatic Fire Detection System                            |
| DSA                 | Distribution Switching & Alarm Unit                        |
| DG Set              | Diesel Generator Set                                       |
| DOD                 | Depth of Discharge                                         |
| EI                  | Electronic Interlocking                                    |
| EMI                 | Electromagnetic Interference                               |
| FRBC                | Float Rectifier Cum Boost Charger                          |
| IPS                 | Integrated Power Supply                                    |
| IS/IEC              | Indian Standard/ International Electrotechnical Commission |
| KAVACH(TCAS)        | KAVACH (Train Collision Avoidance System)                  |
| LCD                 | Liquid Crystal Diode                                       |
| LED                 | Light Emitting Diode                                       |
| LMLA                | Low Maintenance Lead Acid                                  |
| MCCB/MCB            | Moulded Case Circuit Breaker/ Miniature Circuit Breaker    |
| MTBF                | Mean Time Between Failure                                  |
| MOV                 | Metal Oxide Varistors                                      |
| OEM                 | Original Equipment Manufacturer                            |
| PI/RRI              | Panel Interlocking/Route Relay Interlocking                |
| PF                  | Power Factor                                               |
| PWM                 | Pulse Width Modulation                                     |
| RE                  | Railway Electrification                                    |
| RFI                 | Radio Frequency Interference                               |
| SMPS                | Switch Mode Power Supply                                   |
| SPD                 | Surge Protection Devices                                   |
| SEM                 | Signal Engineering Manual                                  |
| VRLA                | Valve Regulated Lead Acid                                  |
| VDU                 | Visual Display Unit                                        |

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**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**

**(RDSO)**

**INDIAN RAILWAY SPECIFICATION FOR  
SMPS BASED INTEGRATED POWER SUPPLY SYSTEM (IPS)**

**FOR**

**SIGNALLING INSTALLATIONS ON INDIAN RAILWAYS  
(RDSO/SPN/165/ 2023, Version 4.0 Amdt.1)**

**0.0 FOREWORD:**

0.1 This specification is issued with the fixed serial number followed by the year of adoption as standard or in case of revision, the year of latest revision.

0.2 This specification is intended chiefly to cover the technical provisions and does not include the necessary provisions of a contract.

0.3 This specification requires reference to following specifications.

|                                     |                                                                              |
|-------------------------------------|------------------------------------------------------------------------------|
| IRS: S 88/2004 or latest            | Low Maintenance Lead Acid Battery                                            |
| IRS:S 93/96(A) or latest            | Valve Regulated Lead Acid Sealed Maintenance Free Stationary Battery         |
| RDSO/SPN/144/2006 or latest         | Safety & reliability requirements of electronic signalling equipment.        |
| IS:9000                             | Basic environmental testing procedure for electronic and electrical item     |
| IRS:S 23                            | Electrical Signalling& Interlocking Equipment.                               |
| IEC-61643 with latest version       | Surge Protective Devices connected to low-voltage power distribution systems |
| EN 55022                            | European Standard for Information Technology Equipment                       |
| MIL HBDK 217F                       | Military hand book "Reliability Prediction of Electronic Equipment"          |
| IEC 61312                           | Protection against Lightning Electromagnetic Impulse                         |
| IEC 61024                           | Protection of structures against Lightning                                   |
| IRS:S 74/89 with latest amendment   | Voltage Regulator-Ferro Resonant                                             |
| EN 50129                            | Railway Application Safety Related Electronic System For Signalling          |
| IEC62305-4:2010 or latest           | Protection against Lightning                                                 |
| FRS no RDSO/RDPM/FRS/2021 or latest | FRS for Remote Diagnostic and Predictive Maintenance System (RDPMS)          |

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0.4 Wherever, in this specification, any of the above mentioned specifications is referred by number only without/with mentioning the year of issue, the latest issue of that specification is implied.

## 1.0 OBJECTIVE & SCOPE:

1.1 This specification covers the requirements of SMPS based integrated power supply system (IPS) suitable to work upto 15KVAsignalling load in RE & Non-RE areas at Stations/LC Gate/IBH/Auto Hut. The IPS system shall be provided with a distribution/ supervisory control / alarm unit for the ultimate rack capacity mentioning overall load also.

1.2 The IPS system is suitable to work with either Low Maintenance cells as per IRS: S 88/2004 or with VRLA Maintenance Free cells as per IRS: S 93/96(A)or any other cells approved by RDSO in later course.

1.3 The SMPS based IPS system may work satisfactorily in indoor environmental condition of most tropical climate However, IPS installed in location Boxes shall be capable to work satisfactorily in outdoor environmental condition of India. The compliance should be as per RDSO/SPN/144/2006 Ver 2 or latest.

## 2.0 FUNCTIONAL REQUIREMENTS:

2.1 The SMPS based Integrated Power Supply (IPS) system is meant to give continuous supply to both AC & DC signalling circuits. The SMPS based IPS system consists of the following:

### 2.1.1 FRBC SECTION (SMPS BASED FLOAT CUM BOOST CHARGER):

This section consists of FRBC (Float rectifier cum boost charger) modules. Distribution/ Supervisory control / Alarm (DSA) unit & metering section with Display unit as illustrated in **Annexure-V**

- (a) **In FRBC:** Input supply shall be 230 V AC with input voltage variation from 150 to 275 V AC at 50 Hz with frequency variation of 48Hz to 52 Hz.
- (b) Output of FRBC shall be 110 V DC to Battery Bank, DC-DC converters, Inverters and directly to different loads through Fuses of sufficient capacity.
- (c) Output of FRBC 110 V DC shall have provision for FLOAT and BOOST charging of Battery bank.

### 2.1.2 AC SECTION:

This section consists of AC-AC Conversion section and DC-AC Conversion section as illustrated in **Annexure-II & Annexure-IIIA:**

#### (a) AC-AC Conversion Section :

This section consists of the combination of Ferro-Resonant based Automatic Voltage Regulator (AVR) 230V AC/230 V AC with Step Down Transformer (230VAC/110VAC) or AC-AC converter(230VAC/110VAC) modules.

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**(b) DC-AC Conversion Section:**

This section consists of the combination of Inverter (110VDC/230VAC) with Step Down Transformer (230VAC/110VAC) or Inverter (110VDC/110VAC) modules.

**2.1.3 DC SECTION:**

This section consists of DC-DC Converters (input 110VDC) with different rating and 110VDC Power Terminations via suitable fuse as illustrated in **Annexure-II & Annexure-III**.

**2.1.4 BATTERY SECTION:**

Battery Section consists of Battery bank of 110 volt DC for supply to Load when there is no availability of power from FRBC Section. If IPS is purchased along with Battery Bank, the same shall be supplied and commissioned with IPS. IPS system should be suitable for charging 110V, 120AH/200AH/300AH battery bank of Low Maintenance cells as per IRS:S 88/2004(or Latest) or VRLA Maintenance free cells as per IRS:S 93/96(A)(or Latest) or any other RDSO approved batteries for S&T installations.

**2.1.5 STATUS MONITORING PANNEL (SM PANEL):**

This panel consists of status indications and critical alarms of IPS to be provided in ASM's room or any other place as per purchaser's requirement.

**2.1.6 REMOTE MONITORING SYSTEM:**

Facility for remote monitoring of IPS to be provided as stipulated in Remote Diagnostic and Predictive Maintenance System(RDPMS)FRS no RDSO/RDPM/FRS/2021 or latest.

**3.0 TECHNICAL REQUIREMENTS:**

**3.1 ELECTRICAL REQUIREMENTS:**

**3.1.1** The IPS shall be suitable to work at a nominal input voltage of 230V AC, 50Hz single phase power supply. The system shall work satisfactorily with input voltage variation from 150 to 275V AC and frequency variation from 48Hz to 52 Hz.

**3.1.2** It shall be ensured by Railway that the capacity of AC input feeder installed at the station is adequate as per the signalling load catered by IPS. All the switchgear and cables shall be adequately rated and shall be of approved makes.

**3.1.3** The accidental short circuit at input feeder shall not cause any interruption to the IPS sub system. The accidental over voltage shall not cause any damage to IPS system.

**3.1.4** There shall be an automatic arrangement for disconnecting the mains within 500 ms to the rack whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The IPS shall resume normal working automatically when the input is restored within the working limits.

**3.1.5** Railway should ensure that the exhaust fans should be made functional in IPS and Battery room before commissioning of IPS.

**3.2 FRBC SECTION (SMPS BASED FLOAT CUM BOOST CHARGER):**

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3.2.1 Standard configuration of FRBC module shall be –

Nominal input - 230V AC/50Hz Single phase (Variation- 150 to 275V/48 – 52 Hz)

Out put- 110V DC/20 Amp rating.

3.2.2 The number of FRBC modules shall be in (n+1) parallel configuration in a single rack as per load. Where 'n' is the actual required number of FRBC modules. One additional FRBC module (spare) shall be provided as a cold standby in the rack.

3.2.3 The SMPS based FRBC should be based on High Frequency (20 KHz and above) Switch Mode techniques.

3.2.4 Resettable fuses shall be provided, wherever appropriate, to protect the module against failure of control / sensing circuit.

3.2.5 The design shall have suitable time delay / hysteresis is to avoid hunting during switching ON and OFF of the system. The module shall disconnect at 150V and reconnect at 170V.

3.2.6 Fans should be used for maintaining the temperature inside FRBC section. ON and OFF switching shall be temperature controlled.

3.2.7 In case of fan failure, the module shall have automatic protection to switch off the module above 70°C and restore automatically with reduction in temperature. It shall not cause any fire hazard. The fan shall also be protected against short circuit by providing a suitable arrangement.

3.2.8 Screen-printed procedure for adjustment of float voltage, boost voltage, battery current limit and other adjustment required to be done in the field shall be prominently visible for ready reference of maintenance staff.

3.2.9 **DC Output Characteristics:**

The module shall be capable of operating in "Auto Float cum-Boost charger" mode. It shall be programmed to operate as a float rectifier or a Boost charger depending on the condition of the battery being sensed by the switching/control unit.

3.2.10 **Auto Float Mode:**

a) Float voltage of each rectifier module shall be set as given in the following table:

| No. of Cells | Auto Float mode voltage |                | Auto Boost mode voltage |                |
|--------------|-------------------------|----------------|-------------------------|----------------|
|              | VRLA Cells              | Conv. LA Cells | VRLA Cells              | Conv. LA Cells |
| 55           | 123.8V                  | 118.25V        | 126.5V                  | 133.1V         |

Normal Float & Boost voltage for VRLA battery is 2.25V and 2.3V/Cell respectively. For conventional battery it shall be 2.15V and 2.42V/cell, respectively. The module should have a range from 2.0 – 2.3V/cell in float mode & 2.2 – 2.5V/cell in boost mode to meet the requirement of VRLA as well as conventional batteries. System must have arrangement to adjust Voltage and current for

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the batteries used in future in place of LMLA or VRLA" Necessary guidelines will be issued separately at the time of approval of batteries.

- b) The DC output voltage shall be maintained within  $\pm 1\%$  of the half load pre-set voltage in the range 25% load to full load when measured at the output terminals over the full specified input range.

### 3.2.11 **Auto Boost Charge Mode:**

In auto boost charge mode, FRBC shall supply battery and equipment current till terminal voltage reaches 2.3V (VRLA battery) /2.42V (Low Maintenance battery) per cell and shall change over to Auto Float mode after a defined delay of 0, 1, 2, 4 hours adjustable, to be set as per battery manufacturer's specification.

### 3.2.12 **Efficiency:**

The efficiency and Power factor of the FRBC in auto float and auto boost mode shall be as follows:

| Description | Nominal input, output & full rated load |                | 150-275V input, 25% to 100% load |      |
|-------------|-----------------------------------------|----------------|----------------------------------|------|
|             | Efficiency %                            | PF             | Efficiency %                     | PF   |
| 110V / 20A  | >90                                     | >0.95 to unity | >85                              | >0.9 |

Note: Active power factor correction circuit shall be adopted.

### 3.2.13 **Total Harmonic Distortion:**

The total line harmonic voltage distortion shall not be more than 10%.The total current harmonic distortion contributed by FRBC at the input shall not exceed 10% for all input condition and load 50% to 100% of the rated capacity.

### 3.2.14 **Current Limiting (Voltage Droop):**

- 3.2.14.1 The current limiting (Voltage Droop) shall be provided for Float/Boost Charge operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current between 2.0 V to 2.5 V/cell.

- 3.2.14.2 The float and boost charge current limit adjustment shall be provided on the front panel.

- 3.2.15 The FRBC modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard. It shall resume normal function automatically after the short is removed. The maximum short circuit current shall not exceed 105% of their rating and there shall not be any damage to the module.

- 3.2.16 Battery path current shall be automatically controlled by the input current in such a way that input current shall not exceed the set limit. The set limit shall be adjustable anywhere between 75 to 100% of full load input current. Provision shall also be made for full utilization of power when DG set is operated.

### 3.2.17 **Soft Start Feature:**

- 3.2.17.1 Slow start circuitry shall be employed such that FRBC module output voltage shall reach its nominal value slowly within 10 to 20 seconds, eliminating all starting surges.

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3.2.17.2 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.

**3.2.18 Voltage Overshoot/Undershoot (with battery disconnected):**

3.2.18.1 The FRBC modules shall be designed to minimize 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 and return to its steady state within 20 milli second for any load of 25% to 100%.

3.2.18.2 The DC output voltage overshoot for a step change in AC mains from 150V to 275V shall not cause shut down of FRBC module and the voltage overshoot shall be limited to  $\pm 5\%$  of its set voltage and return to steady state within 20ms.

3.2.18.3 The modules shall be designed such that a step load change of 25% to 100% or vice-versa shall not result in DC output voltage overshoot/undershoot of not more than  $\pm 5\%$  of the set value and return to steady state value within 10 millisecond without resulting the unit to trip.

**3.2.19 Electrical Noise:**

3.2.19.1 The FRBC module shall be provided with suitable filter on the output side.

3.2.19.2 A resistor shall be provided to discharge the capacitors after the FRBC module has stopped operation and the output is isolated.

3.2.19.3 The psophometric noise (e.m.f. weighted at 800 Hz), with a battery of appropriate capacity connected across the output should be within 5 mV, while delivering the full rated load at nominal input (230V single-phase supply). For test purpose this shall be taken as equivalent to 10mV when the battery is not connected.

3.2.19.4 The peak- to- peak ripple voltage at the output of the rectifier module without battery connected shall not exceed 300 mV at the switching frequency measured by a storage oscilloscope of 50-60 MHz band-width.

**3.2.20 Parallel Operation:**

3.2.20.1 The FRBC modules shall be suitable for operating in parallel on active load sharing basis with one or more modules of same type, make and rating.

3.2.20.2 The current sharing shall be within  $\pm 10\%$  of the individual capacity of each FRBC in the system when loaded between 50 to 100% of its rated capacity.

**3.2.21 Protection:**

3.2.21.1 It shall be ensured that the o/p will not exceed set voltage (2.37V/2.5V per cell) by incorporating secondary backup loop or by other means which will prevent the o/p voltage from exceeding the set voltage, thereby shutting down the FRBC should not occur.

3.2.21.2 Shutting-off faulty FRBC module shall not affect the operation of other FRBCs operating in the rack.

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- 3.2.21.3 It shall be ensured that the battery should not get discharged through FRBC module. In any case, the discharge current i.e. reverse leakage current, shall not be more than 100 mA.
- 3.2.21.4 The over voltage protection circuit failure shall not cause any safety hazard.
- 3.2.21.5 Arrangement should be made for Class “C” type MCB as per IS. 13947 in live AC input line.
- 3.2.21.6 Arrangement should be made for isolation of Batteries during replacement/maintenance of Batteries.

### 3.3 AC SECTION:

Output of Inverter, step down transformer, AVR & AC-AC converter shall be brought to one place at the rear of the cabinet. 30 Amp capacity TB type terminal capable of termination of 10-sq. mm cable shall be provided. Proper identification marking shall be provided on/near the terminals.

#### 3.3.1 INVERTER:( INV:110VDC/230VAC or INV: 110VDC/110VAC)

With reference to decision for decontrol Inverter specification vide letter no 2019/SIG/86thSSC dtd 15.03.2022, it was advised to buy the inverter with IPS specification if required. Hence ,vendor shall be capable to supply stand alone Inverter/ combination of INV1 and INV 2 with switching option from INV1 to INV2 if Railway demands.

- 3.3.1.1 The inverter shall be of IGBT or latest technology based.
- 3.3.1.2 The inverter shall be protected against overload and short circuit. Whenever the failure condition persists, it shall trip as long as the short circuit persists and automatically gets restored to the normal output voltage when the Short circuit is rectified. Such a sustained Short Circuit shall not (a) cause any damage to the module (b) feed fault current into the load. Inverter overload indication shall appear at 110% of rated load. If the problem still persists, the protection should permanently get latched and inverter should not be switched on again unless fault is cleared. After restoration of fault, an arrangement shall be made to switch ON Inverter either manually or automatically.
- 3.3.1.3 Inverter shall be designed for continuous operation for an input voltage of 98V to 138V DC at a nominal of 110V DC, and shall be rated for an output of 230V AC or 110 V AC as illustrated in **Note of Annexure-III**.
- 3.3.1.4 The Inverters should work in Main and Standby mode. The output of inverters shall be linked in such a way that on failure of Main inverter, the standby inverter shall supply to load automatically within 60ms. If the standby Inverter also fails then load shall be automatically transferred to AVR/AC-AC converter within 60ms. As soon as one of inverter becomes healthy, the load shall be automatically transferred back to inverter. The failure of any inverter shall be indicated using LED. The changeover arrangement must have MTBF of 35,000 hrs.
- 3.3.1.5 The inverter shall be suitable for on-line application.

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- 3.3.1.6 The input & output of inverter shall be galvanically isolated through transformer from each other. It should meet the criteria mentioned in clause 9.5 & 9.6 of RDSO/SPN/144/2006 or latest.
- 3.3.1.7 Each inverter shall have suitable arrangement for connecting and disconnecting the DC input. The arrangement shall have MTBF better than 35000 hrs.
- 3.3.1.8 The fan, if provided, should have MTBF better than 70,000 hours at 40°C. The switching ON & OFF the fan shall be with temperature controlled.
- 3.3.1.9 Voltage overshoot and under-shoot in the first cycle for complete load shut off shall be restricted to 20%.
- 3.3.1.10 The output voltage waveform shall be sine wave. Total harmonic distortion of the output shall not exceed 8% under any condition specified in clauses 3.3.1.13.
- 3.3.1.11 The no-load current at rated input voltage shall not exceed 10% of the full load input current.
- 3.3.1.12 The inverter shall be capable of delivering 125% of rated full load for a period of 24 hours. It should be capable of delivering 200% of the rated full load for a period of 300 ms in order to cater for the high in-rush current at the time of switching 'ON' of the inverter.
- 3.3.1.13 The output of inverters shall be regulated to 230V  $\pm$  1% for INV (110V DC/230VAC) or 110V  $\pm$  1.5% for INV (110V DC/110VAC) for an input variation of 98V-138V DC and for a simultaneous load variation of 25% to 125% of the rated capacity.
- 3.3.1.14 The overall watt efficiency of the inverter shall not be less than 85% at full load for the entire input range of 98V to 138V DC.
- 3.3.1.15 The unit shall be capable to withstand 20 cycles / hrs of 1.5 minute each ON and OFF at rated load.
- 3.3.1.16 Output voltage of inverter shall not exceed beyond 230V  $\pm$  1%(110V DC/230VAC) or 110 V  $\pm$  1.5%(110V DC/110VAC) and frequency 50Hz  $\pm$  1Hz under any circumstances.
- 3.3.2 FERRO-RESONANT TYPE AUTOMATIC VOLTAGE REGULATOR (AVR)**
- 3.3.2.1 The design of the Automatic Voltage Regulator shall cater for any load from no load to full load of its rated capacity.
- 3.3.2.2 The voltage regulator shall be completely static without any moving parts.
- 3.3.2.3 The AVR shall be suitably screened so that other electronic equipment placed side by side of the regulator is not affected by the electromagnetic radiation of the regulator.
- 3.3.2.4 The AVR shall be of natural air-cooled type and shall be suitable for indoor use in the cabins where maximum ambient temperature can reach upto 50°C.
- 3.3.2.5 The regulator shall function satisfactorily under shock and vibration conditions encountered by the side of railway track. Main transformer shall be mounted on anti-vibrating padding.

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- 3.3.2.6 AC Metal Can Capacitors of 600V rating of approved type with in-built wire shall only be used. The capacitors shall be mounted at a minimum distance of 2" away from the main transformer's top plate with metal partition in between the transformer and capacitor. This partition shall be of heat insulating material as the purpose is to protect capacitors from heat.
- 3.3.2.7 The output tapings at 0,220, 230& 240V shall be provided for AVR.
- 3.3.2.8 Transformers and inductors/ chokes used, shall be vacuum impregnated and shall be of natural air-cooled type conforming IS: 6297 (Category 3 & Grade 2). Class F or higher grade insulating material as per IS:1271 and polyester enameled copper winding wire conforming to IS 13730(Pt. 3) shall be used for winding transformers and inductors/chokes. The gauge of winding wires shall be such that the current density shall not exceed 1.6A/sq.mm.
- 3.3.2.9 Two pole Type C MCB or ON/OFF rotary switch conforming to IS: 4064 (Pt.I)shall be provided for input to the regulator.
- 3.3.2.10 A LED to indicate that the unit is 'ON' shall be provided on the front panel.
- 3.3.2.11 The output voltage shall remain at the nominal value of 230/± 1% at all the loads varying from 25% load to full load keeping the input voltage constant at 230V 50Hz.
- 3.3.2.12 The regulator shall work satisfactorily within supply frequency of 50Hz ± 2.5 Hz. The value of output voltage at rated load with an input of 230V at 50 Hz shall be taken as the reference output voltage for individual unit. When input frequency is varied from 47.5 Hz to 52.5 Hz, keeping the input voltage constant, the output voltage of the regulator unit shall be maintained within ± 3% of the reference output voltage for ± 1 Hz variation and within ±6% for ± 2 Hz frequency variation.
- 3.3.2.13 The regulator shall work satisfactorily within a range of 160V to 270V input at 50Hz mains supply. The output voltage shall be maintained within 230/ ± 1% when the unit is connected to rated load.
- 3.3.2.14 The response time of regulator for sudden changes of 50 V AC input voltage or load variation from 25% to 75% of the rated load shall be such that the output voltage should settle at 230/ ± 1% within 3 cycles/60mseconds.
- 3.3.2.15 The no load current shall not be more than 25% of the rated input current and the no load power shall not be more than 10% of the rated output power at nominal input voltage of 230V for 230 AC at 50Hz.
- 3.3.2.16 The overall watt efficiency shall not be less than 85%.
- 3.3.2.17 The total harmonic distortion measured at the output of the regulator shall not exceed 8% under any working conditions specified in Clauses 3.3.2.11,3.3.2.12 & 3.3.2.13.
- 3.3.2.18 The voltage regulator shall be capable of handling any load from unit power factor to 0.8 lagging, without degrading total harmonic distortion and regulation.

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- 3.3.2.19 When continuously operating at full load at any ambient condition specified in clause 1.3, the regulator shall withstand short-circuit on output side for one hour without any damage or deterioration to the regulator or any of its components.
- 3.3.2.20 The resonant voltage across the capacitor bank shall not exceed 480V at all input voltage and frequency conditions i.e 160-270V & 47.5Hz to 52.5Hz at no load.
- 3.3.2.21 Suitable surge voltage protection shall be incorporated in the circuit, preferably with high isolation between primary and secondary sides.
- 3.3.2.22 Ferro resonant voltage regulator for Signal load shall always be in 'switched on' condition and shall supply the load within 60 ms in case of any failure in Inverter/s and/or inverter changeover arrangement. As soon as any one of Inverter becomes healthy, the load shall be automatically transferred back to inverter within 60ms.
- 3.3.3 STEP DOWN TRANSFORMER:**  
With reference to decision for decontrol step down transformer specification vide letter no 2019/SIG/86thSSC dtd 15.03.2022, it was advised to buy the transformer with IPS specification if required. Hence, vendor shall be capable to supply Step down transformers if Railway demands.
- 3.3.3.1 Terminals & associated screws shall be of nickel-plated brass, and shall be of the top screw pillar type, securely fixed.
- 3.3.3.2 The transformer shall be of double wound type and shall be designed for an input voltage of 230V  $\pm$  2%, 50Hz.
- 3.3.3.3 The transformer shall have separate input and output windings.
- 3.3.3.4 The primary of the transformer is 230V. The secondary winding shall have tapping at 0, 100, 110, 120 & 130 volts at no load.
- 3.3.3.5 The gauge of winding wires shall be such that current density does not exceed 2A/mm sq.
- 3.3.3.6 A rotary switch/ MCB (Type C) of 10A or above shall be provided for switching ON/OFF the transformer.
- 3.3.3.7 The size of the core shall be as small as possible commensurate with the electrical characteristics required by this specification.
- 3.3.3.8 The core of the transformer shall be such that its Electro-magnetic property will not be affected due to ageing.
- 3.3.3.9 The body of the core is required to be earthed and one earth terminal shall be provided for this purpose. Suitable marking shall be made near the earth terminal.
- 3.3.3.10 The efficiency of the transformer at rated load with nominal input shall not be less than 90%.

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- 3.3.3.11 The appropriate voltage shall be legibly & indelibly engraved near the input and output terminals.
- 3.3.3.12 An HRC fuse of appropriate rating shall be provided at the input of transformer.
- 3.3.3.13 230V AC at 50 Hz shall be applied on primary side between terminals '0' and '230V' and the voltages across different tapping on the secondary side shall be measured, which shall be within  $\pm 1.5\%$  of the nominal value.
- 3.3.3.14 The open circuit secondary voltage and the primary no load current of the transformer shall be measured with the primary winding connected to 230V, 50Hz supply and the secondary winding open circuited. The open circuit secondary voltage at different tapping of the secondary windings shall be within  $\pm 1.5\%$  of the nominal values. The primary no load current shall not exceed 10% of the rated full load primary current for all transformers.
- 3.3.3.15 The percentage voltage regulation shall not be more than 5%.
- 3.3.3.16 **Induced High Voltage Test-** The transformer shall withstand without break down, when 440 volt 100 Hz AC is applied to the primary winding, with secondary winding open-circuited. The voltage shall be raised from one third of the maximum value to maximum value as rapidly as is consistent with accurate reading of the indicating instrument. The full test voltage shall be maintained for one minute and shall then be reduced to the one third of the value before being switched off. At the end of the test the transformer shall be tested for the following:
- a) Insulation resistance (Clause 3.22.2)
- b) Open circuit test (Clause 3.3.3.14)
- 3.3.3.17 The transformer shall withstand without any damage short circuit of secondary windings momentarily when primary is fed with 230V AC at terminals 0V and 230V. The test shall be carried out after bypassing the fuse.
- 3.3.3.18 Applied high voltage test as per clause 3.22.3 shall be repeated after short circuit test.
- 3.3.3.19 Transformers and inductors/ chokes used, shall be vacuum impregnated and shall be of natural air-cooled type conforming IS: 6297 (Category 3 & Grade 2). Class F or higher grade insulating material as per IS:1271 and polyester enameled copper winding wire conforming to IS 13730(Pt. 3) shall be used for winding transformers and inductors/chokes. The gauge of winding wires shall be such that the current density shall not exceed 2 A/sq.mm.
- 3.3.3.20 All exposed metal parts of the transformer including laminations shall be protected against corrosion.
- 3.3.4 AC-AC CONVERTER:**
- 3.3.4.1 The design of the AC-AC Converters shall cater for any load from no load to full load of its rated capacity.

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- 3.3.4.2 AC-AC Converters shall be completely static without any moving parts. The input & output of AC-AC converter shall be galvanically isolated through transformer from each other. It should meet the criteria mentioned in clause 9.5 & 9.6 of RDSO/SPN/144/2006 or latest.
- 3.3.4.3 AC-AC Converters shall be suitably screened so that electronic equipment placed side by side of the converter is not affected by the electromagnetic radiation of the converter.
- 3.3.4.4 AC-AC Converters shall be of forced cooling by provision of temperature-controlled fans and shall be suitable for indoor use in the cabins where maximum ambient temperature can reach up to 50 deg with fan on at > 55 deg and off at < 55deg.
- 3.3.4.5 AC-AC Converter shall function satisfactorily under shock and vibration condition encountered by the side of railway track.
- 3.3.4.6 AC-AC Converter output voltage 110VAC (with adjustable POT from 110VAC to 130VAC) shall be provided.
- 3.3.4.7 Provision for disconnection of Input supply shall be provided to AC-AC converter through switch/MCB or any other means. MTBF of provision arrangement must be more than 35000 hrs.
- 3.3.4.8 LED indication for input OK, output OK, unit on load & output overload shall be provided.
- 3.3.4.9 The output voltage shall remain at the nominal value of 110VAC $\pm$  1.5% at all the loads varying from 25% load to full load keeping the input voltage constant at 230VAC/50hz.
- 3.3.4.10 The AC-AC Converter shall work satisfactorily within supply frequency of 50Hz $\pm$  2.5Hz. The value of output voltage at rated load with an input of 230VAC at 50hz shall be taken as the reference output voltage for individual unit. When input frequency is varied from 47.5Hz to 52.5Hz, keeping the input voltage constant, the output voltage of the AC-AC Converter shall be maintained within  $\pm$ 1.5% of the reference output voltage for  $\pm$ 1Hz variation and within  $\pm$ 1% for  $\pm$ 2Hz frequency variation.
- 3.3.4.11 The AC-AC converter shall work satisfactorily within a range of 160V to 270V input at 50hz mains supply. The output voltage shall be maintained within 110V  $\pm$ 1.5% when the unit is connected to rated load.
- 3.3.4.12 The response time of AC-AC converter for sudden changes of 50VAC input voltage or load variation from 25% to 75% of the rated load shall be such that the output voltage should settle at 110VAC  $\pm$ 1.5% within 3 cycles/60m seconds.
- 3.3.4.13 The no load current shall not be more than 25% of the rated input current and the no load power shall not be more than 10% of the rated output power at nominal Input voltage of 230VAC for 110AC at 50Hz.
- 3.3.4.14 The overall watt efficiency shall not be less than 85%.

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- 3.3.4.15 The total harmonic distortion measured at the output of the AC-AC converter shall not exceed 8% under any working conditions specified in Clauses 3.3.4.9, 3.3.4.10 & 3.3.4.11.
- 3.3.4.16 The AC-AC converter shall be capable of handling any load from unity power factor to 0.8 lagging, without degrading total harmonic distortion and regulation.
- 3.3.4.17 When continuously operating at full load at any ambient condition specified in clause 1.3, the AC-AC converter shall withstand short-circuit on output side for one hour without any damage or deterioration to the AC-AC converter or any of its components..
- 3.3.4.18 Suitable surge voltage protection shall be incorporated in the circuit.
- 3.3.4.19 AC-AC converter for signal load shall always be in 'switched on' condition and shall supply the load within 60 ms in case of any failure in inverter/s and /or inverter changeover arrangement. As soon as any one of inverter becomes healthy, the load shall be automatically transferred back to inverter within 60ms.

### 3.4 DC SECTION:

Output of DC-DC converters shall be brought to one place at the rear of the cabinet. 30 Amp capacity TB type terminal capable of termination of 10-sq. mm cable shall be provided. Proper identification marking shall be provided on/near the terminals.

#### 3.4.1 DC-DC CONVERTER:

With reference to decision for decontrol DC-DC converter specification vide letter no 2019/SIG/86thSSC dtd 15.03.2022, it was advised to buy the DC-DC converters with IPS specification if required. Hence ,vendor shall be capable to supply stand alone DC-DC converter/ combination of DC-DC converters if Railway demands.

- 3.4.1.1 The DC/DC converter covered under this specification shall work satisfactorily meeting all the prescribed parameters as long as the DC input voltage is within 98V to 138V.
- 3.4.1.2 DC- DC converters and Fuse terminations shall be connected in order mentioned in **Annexure IIIA**. All modules of DC-DC converters with different ratings are optional and shall be supplied as per purchaser requirement.
- 3.4.1.3 All components dissipating 3W or more power shall be mounted so that the body is not in contact with the board unless a clamp, heat sink or other means are used for proper heat dissipation.
- 3.4.1.4 Each converter shall be provided with a proper plug in arrangement for DC input & output. A toggle switch / push button switch shall be provided for switching ON/OFF the unit.
- 3.4.1.5 All modules except block Tele shall work on active load sharing basis without master /slave operation, Failure of any module shall not cause malfunction in other modules. The current sharing shall remain within  $\pm 10\%$  for 50% to 100% load.
- 3.4.1.6 The unit shall be provided with over-load protection, over-voltage protection and output short circuit protection with fold back characteristics. The over-load protection shall be effective at 105% and output short circuit protection shall be effective at 110% of the rated current.

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The DC over voltage protection shall be auto tracking type. Over voltage trip shall be set at approximately 110% of the maximum output voltage. For example in a 24V-32V DC-DC Converter module if over voltage shall be  $32 \times 1.1 = 35.2$  V approximately and so on. The output voltage settability of the converter shall be within the -2% of the minimum rated voltage and +2% of the maximum rated voltage of the converter.

- 3.4.1.7 The output shall be free from overshoot because of "Turn on /Turn off" or power failure or when the battery charger is switched ON/OFF.
- 3.4.1.8 In case of failure of DC-DC converter the output voltage shall not exceed beyond pre-set value.
- 3.4.1.9 The no load input current shall not be more than 10% of the rated input current at maximum full load for all setting of output voltage and input voltage variation from 98V to 138V of nominal input voltage for DC-DC Converters of 50 VA and above.
- 3.4.1.10 The overall efficiency of the converter at full load shall not be less than 75%for converters rating from 50VA to less than 150VA at rated load and 80%for converters of 150VA or more rated output at 98V to 138V of nominal input voltage. For converters of rating 10VA –50VA, overall efficiency shall be greater than 50%.The efficiency shall be measured at the maximum output voltage of the specified range.
- 3.4.1.11 Each DC-DC converters shall be of modular type which shall be fitted in main rack. The input and output connections shall be made using irreversible plug in connectors of appropriate rating.
- 3.4.1.12 Each converter shall be designed for an input voltage of 98V to 138V DC. The output regulation shall be  $\pm 1\%$  of set value from 10% load to full load for the entire input range. DC-DC converter for Block Tele shall work at input voltage range of 90-140 VDC. The regulation however shall be tested for 98-138V DC input variation.
- 3.4.1.13 Each DC-DC Converter shall be provided with voltage & current testing sockets on the front panel for the purpose of output voltage & current measurement in the common voltmeter & ammeter using patch cords & jacks or with display on each module.
- 3.4.1.14 Each DC-DC converter shall be provided with a precision type potentiometer inside it for adjusting the output voltage in step of 0.1 volt.
- 3.4.1.15 The output must be isolated from input.
- 3.4.1.16 Each DC-DC converter shall have blocking diodes at the output. The test points shall be provided before the blocking diode or voltage and current may be displayed on module itself.
- 3.4.1.17 The converter shall have self-resetting type protection from over load/ short circuit of DC output.
- 3.4.1.18 The output ripple (peak to peak) of the converter shall not be more than 50mV or 10 mV rms at full load.
- 3.4.1.19 The psophometric noise for block line and block tele shall not be more than 4 mV.

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### 3.5 BATTERY SECTION:

- 3.5.1 Battery racks (MS) for VRLA batteries and Wooden rack for low maintenance (LMLA) batteries, along with its accessories duly approved by purchaser, shall also be supplied with battery bank (optional based on purchaser requirement).
- 3.5.2 The battery is to be installed in a separate room in case of LMLA Batteries. Low Maintenance batteries are to be charged at the site by OEM for which power supply shall be arranged by Railways. A test certificate of initial charging/capacity testing shall be submitted by OEM to Railways.
- 3.5.3 OEM shall supply copper cable of suitable dia as per IS: 694 and grade 1100V for connecting IPS to Battery bank (distance to be given by Railways at the time of indenting) as given below –
- For 120AH battery – 10Sq.mm
  - For 200AH battery – 16 Sq.mm
  - For 300AH battery – 25 sq.mm
- 3.5.4 **Battery Health Monitoring**
- 3.5.4.1 **Battery Health Monitoring in Auto Mode:** To keep the battery in healthy state, the battery condition shall be continuously monitored. On restoration of AC mains after an interruption, depending on the battery condition sensed, the system shall change over to Auto Boost Mode to charge the battery at higher voltage of 2.3/2.42V/cell for VRLA /Low Maintenance battery respectively till the battery is fully charged. It shall come back to auto float mode as defined in clause 3.2.10.
- 3.5.4.2 **Battery Current Limiting Circuit:** To ensure the availability of required load connected and safety of the battery in auto mode, the battery charging current limit shall be settable (5 –15% of battery AH capacity) as per requirement.
- 3.5.4.3 **Battery under voltage isolation:** The system shall have provision for battery isolation which shall be effective at:-
- For VRLA Battery: 1.80V/cell ( $\pm 0.012$ V/cell)
  - For low maintenance lead acid battery: 1.85V/cell ( $\pm 0.012$ V/cell)
  - Battery under voltage adjustment shall be provided inside the switching control unit/ DSA. This setting shall be adjustable from 1.80 to 2.0V/cell. Battery shall get reconnected after restoration of mains.
  - Arrangement should be done in such a way that health of batteries may be monitored from remote (Divisional control or any other place where purchaser demands) also. This arrangement may be done either through Data logger or through RDPMS system.
- 3.5.4.4 **Temperature Compensation for VRLA Battery:** There shall be provision for monitoring the temperature of battery and consequent arrangement for automatic temperature compensation of the FRBC output voltage to match the battery temperature dependent charge characteristics. Output voltage of the FRBC shall decrease or increase as per the type of the battery used by the purchaser. Failure of

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temperature compensation including sensor shall create an alarm and shall not lead to abnormal change in output voltage.

**3.5.4.5 Battery Reverse Polarity Protection:** Protection for battery reverse polarity shall be provided in the system. The reverse polarity indication shall be provided near the battery terminal.

**3.5.4.6** The system configuration shall be made either with cable or bus bar. Bus bar of high conductivity electrolytic copper strips with purity of 99.9% as per BIS 613 latest issue and shall be able to withstand maximum load and battery current. The bus bar/cable sizes shall be sufficient to cater current density upto 2 Amps per sq.mm. The size of bus bar shall not be less than 25mm x 5mm in any case.

### **3.6 DISTRIBUTION/SUPERVISORY CONTROL /ALARM (DSA) UNIT**

**3.6.1** The IPS system shall be provided with a distribution/ supervisory control / alarm unit for the ultimate rack capacity as indicated in clause 1.1.

The unit shall comprise of the following:

- Termination for the batteries.
- Termination for the load (DC-DC converter, Inverters).
- Termination for AC input to the AVR and AC-AC converters.
- Termination for AC and DC to FRBC modules.

#### **3.6.2 ACCESSIBILITY**

**3.6.2.1** The termination points shall be easily accessible.

**3.6.2.2** AC and DC terminals shall be separated by physical barriers to ensure safety.

**3.6.2.3** All the terminals except AC earth shall be electrically isolated.

**3.6.2.4** All the AC, DC and Control/Alarm cabling with proper tray shall be supplied with the system.

#### **AC termination arrangement:**

The input terminals shall be clearly marked as L & N for mains supply voltages.AC input termination shall be suitably protected against accidental touch/contact with the working staff for their protection and shall also have clear and prominent 'DANGER' Marking.

#### **3.6.2.5 DC termination arrangement:**

Connection between the FRBC and DC distributions shall be through a proper rated lugged cable.

- The AC input connection to the FRBC module shall be terminated by means of plug and socket arrangement as per specification No. UL 977 & DIN 41576 or any other approved provision.
- The DC output connection should be taken through irreversible plug and socket having power pins with locking arrangement.
- The output of each FRBC in the positive lead shall be taken through the HRC fuse of 1.5 times of rated capacity of FRBC
- In all cases, the male connector shall be mounted in the FRBC module and the female connector shall terminate the cable.

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- e) To prevent hazards or damaging conditions, all plug-in components shall be non-interchangeable.
- f) All the connections between DSA unit and FRBC shall be through proper rated cables only.
- g) Circuit breakers at the input of each FRBC shall be easily accessible and rated to 25A for 110V/20A module.
- h) The DC output to battery and load shall be through bus bar or cable.
- i) Battery fuse shall be of 1.5 times of maximum current that passes to / from battery. Fuse at the O/P of FRBC rack shall be of 1.5 times the designed O/P current required for the system.
- k) All DC positive & negative terminals shall be clearly marked and shall be suitable for minimum 10sq. mm cable size. All conductors shall be properly rated to prevent excessive heating.
- l) 110 V DC terminations for connecting the loads shall be provided through fuse of proper rating as per **Annexure-II & Annexure-IIIA**.

### 3.7

#### STATUS MONITORING PANEL:

##### 3.7.1

The Status monitoring panel (SM Panel) shall be of wall mounting type. OEM shall supply 12 core, 1.5 sq.mm signalling cable as per IRS:S 63/2014(or latest) or 0.9 mm 6 Quad cable s per IRS:TC-30/2005 or latest or Optical Fiber Cable (OFC) as per IRS:TC 55/2006 or latest for connecting IPS to Status Monitoring Panel. Where the requirement of cables is more than 100 meter then it will be provided by Railway.

The panel shall have following LED indications and alarms with resetting switch:

|   | Instruction               | Condition       | LED Ind. | Remark                                                                                                                                             |
|---|---------------------------|-----------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| A | Run Gen set               | 50% DOD         | RED      | Audio / visual alarm. Alarm can be acknowledged for audio cut off.                                                                                 |
| B | Emergency start generator | 60% DOD         | RED      | -do-                                                                                                                                               |
| C | System shut down          | 70% DOD         | RED      | Signal feed cut off and all DC-DC converters to work. Audio alarm will continue till Generator is started.                                         |
| D | Call S & T staff          | Equipment fault | RED      | Failure of any module or in case battery gets disconnected from circuit will give the alarm in panel. Alarm can be acknowledged for audio cut-off. |

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| E | Stop Gen Set | FRBC change over to float mode | GREEN | Audio /Visual alarm |
| F | Mains Fail   | Mains not available            | RED   | Audio /Visual alarm |

3.7.2 Provision of fault logging for 15 days to be ensured. Audio alarm in case of A, B & C shall be of one type of tone and there shall be different tone for the case of D, E & F .Alternatively, manufacturer may provide preprogrammed voice announcement alarm arrangement as per instruction mentioned in clause 3.7.1.

3.7.3 In A, B & C conditions, the visual LED indication will remain lit until fault is cleared or the DG set is started and battery is charged upto 110V i.e. 2V/cell as the case may be until reset push button is pressed. In case of D condition, if fault is not cleared, the LED will continue to glow, even if reset push button is pressed.

### 3.8 CONSTRUCTION:

3.8.1 Construction of panels shall be as per **Annexure- V**. As all modules are optional and will be supplied as per purchaser requirement, selection of these modules may be done as per **Annexure-III A**.

3.8.2 The individual cabinet shall be within the overall dimensions of 2000-mm max. height ,750 mm. max. depth and 750 mm max. width. If additional cabinet is required to accommodate more modules, the height and depth of all cabinets shall be of equal size. Each cabinet will have min 10-mm thick anti-vibrating pad and 75 mm x 5-mm bottom channel as per **Annexure-V**.

3.8.3 The rack structure and the module frame shall be made up of rigid framework of steel profiles. The door, if used, shall be of hinged type. The rear panel shall be provided with proper ventilation arrangement. Temperature controlled fans for forced cooling shall be provided in such a way that overall temperature of rack must not increase from prescribed limit.

3.8.4 The racks and module cabinets shall be of robust construction. They shall be housed in self-supporting cubicles made of cold rolled closed annealed mild steel sheet/Stainless steel sheet (SS-304 or better) of thickness not less than 1.6mm. However for IPS provided in Location Boxes to be made with SS-304 (or better) only. The rack shall be adequately ventilated. The ventilating opening shall be less than 3mm size for protection against entry of lizard's etc. The rack shall conform to IP31 type of protection as specified in table 1 of specification no. IS 2147-1962 for indoor equipment and IP 53 for IPS installed in location boxes. No treatment required for Stainless Steel (SS-304 or better) racks. There shall not be any physical deterioration of racks and cabinets within warranty period.

3.8.5 The racks and the modules shall be treated with zinc chromate primer followed by electrostatic epoxy powder coating paint finished, passivation shall be done through

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seven stage process/sand blasting. Small metal parts such as nuts, bolts and washers shall be chrome plated. All other metal parts of the rack shall be plated for protection against corrosion. No treatment required for stainless steel (SS-304) racks.

- 3.8.6 The racks and the module cabinets shall be free from sharp edges & sharp corners.
- 3.8.7 Provision of doors are optional, the cabinet sides shall have 3mm louvers covered with wire mesh. However, if the doors are not provided, the sub system shall have proper enclosures so that any reptile/ insect shall not enter in the IPS cabinet. The magnetic latches/handle shall be provided on the doors.
- 3.8.8 The racks and the modules shall be designed for easy maintenance and installation.
- 3.8.9 Facility shall be provided at the top of the rack to connect external AC power and lightning arrestors (if provided inside the rack). Where cables pass through metal panels, suitable rubber grommets shall be provided to protect cable from damage.
- 3.8.10 The modules shall be of modular type. The module shall be easily mounted or removed from the front side of the rack. The module shall be designed to slide into the rack on a suitable mechanical arrangement. Suitable arrangement shall be made for pulling out each module separately. The associated AC input, DC output connection, control/alarm & interface cable connecting the module shall be disconnected/installed easily without causing any interruption/damage to supply & working module.
- 3.8.11 The input and output terminals shall be accessible only when the cover of the cubicle is removed. All the terminals shall be clearly, neatly and indelibly marked to correspond with the wiring diagram for easy identification.
- 3.8.12 Input and output connections of SMR, DC-DC converter, Inverter, AVR, AC-AC converter and Step down Transformer shall be made using plug & socket of adequate rating having power pins with locking arrangement. The male connector shall be mounted on the device and the female connector shall be terminated on the cable. Use of terminal blocks for input and output connections is not accepted.
- 3.8.13 The finish of steel and panels shall conform to relevant IS specification. The colour scheme shall be as follows:
- a) Rack & doors                      Pebble Grey RAL 7032 or Light Grey RAL7035
- b) All IPS modules shall harmoniously match with rack color. For clear identification of different modules, a framework on front of each modules (min 5 mm and max 10mm)with permanent color shall be used as per table below:

| SN | Modules               | Color of Framework |
|----|-----------------------|--------------------|
| 1  | DC-DC converter       | Green              |
| 2  | FRBC                  | Blue               |
| 3  | INV                   | Red                |
| 4  | AVR/AC-AC converter   | Brown              |
| 5  | Step down Transformer | Black              |

- 3.8.14 AC/DC Section shall have proper identification marking/protection for AC/DC monitoring points to avoid any misuse and protection against any accidental short circuit.

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3.8.15 Baffles to be provided at the rack level for forced ventilation of individual modules.

### 3.9 METERS & DISPLAY:

3.9.1 All the parameters such as voltage, current and temperature (optional) shall be displayed through LCD/LED digital display meter with accuracy of  $\pm 1\%$ . Multi Function Meters (MFM) may be used.

3.9.2 LCD/LED display shall be provided on the top of or on individual modules for FRBC, AC Section and DC section. LCD/LED display provided on Top of section shall have min 12mm numerical display height on the front panel with extendable cords for measurements of output voltages and currents. If it is provided in each module individually, then height of LCD/LED display shall be min 8mm.

#### 3.9.3 FRBC Section:

3.9.3.1 Digital meters with LED/ LCD display having min 12mm numerical display shall be provided on top of the charger panel and it shall be clearly indicated for charging and discharging with magnitude of battery current. The selector switch/Key Pad for meter shall not be at a height of more than 1800 mm from the ground.

- a) AC Volt meter      0-300V      for AC input voltage
- b) AC Ammeter      0-50A      for AC input current
- c) DC Voltmeter      0-200V      for charger output voltage
- d) DC Ammeter      0-50A      for charger output current/charge/  
Discharge current.

3.9.3.2 A selector switch/Key Pad shall be provided for reading Total/ Charge / Discharge current.

3.9.3.3 Provision of individual voltage and current at each module shall also be displayed with min 8mm display height.

3.9.3.4 The DC meters shall work even when the AC supply is not available.

#### 3.9.4 AC SECTION:

Provision of Display may be achieved either with combined display or with individual display in each module.

3.9.4.1 **Provision with combined Display:** AC digital volt meter (0-300V) & AC digital Ammeter (0-20A) with LED/ LCD display having min 12mm numerical display shall be provided on the front panel with extendable cords for measurements of output voltages of the following:

- a) Inverter 1
- b) Inverter 2
- c) AVR Signal
- d) AVR Track
- e) Tx. ( Signal 1) (Optional with INV (110VDC/110VAC)& AC-AC converter)
- f) Tx. ( Signal 2) (Optional with INV (110VDC/110VAC)& AC-AC converter)
- g) Tx. (Track1) (Optional with INV (110VDC/110VAC)& AC-AC converter)
- h) Tx. ( Track2) (Optional with INV (110VDC/110VAC)& AC-AC converter)
- i) AC-AC converter ( Optional with AVR and Step Down Tx)

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### 3.9.4.2 Provision with Individual display at each module:

Provision of individual voltage and current at each module shall be displayed with min 8mm display height.

### 3.9.5 DC SECTION:

Provision of Display may be achieved either with combined display or with individual display in each module.

**3.9.5.1 Provision with combined Display:** DC digital Voltmeter & Ammeter with LCD/LED display having min 12mm numerical display height shall be provided on the front panel with extendable cords for measurements of output voltages & current of DC-DC converters.

### 3.9.5.2 Provision with Individual display at each module:

Current and Voltage shall be displayed with LCD/LED display having min 8 mm numerical display on each DC-DC module.

## 3.10 ALARMS & INDICATION:

### 3.10.1 DSA Unit:

#### 3.10.1.1 Status Indication:

| Description        | Nomenclature | Indication |
|--------------------|--------------|------------|
| a) Mains available | MAINS        | Amber      |
| b) Mains fail      | MAINS FAIL   | Red        |

#### 3.10.1.2 Alarm Indication:

| Description                          | Nomenclature                  | Indication |
|--------------------------------------|-------------------------------|------------|
| a) Load voltage high                 | OUTPUT VOLT HIGH              | Red        |
| b) Mains out of range                | MAINS VOLT LOW /HIGH          | Red        |
| c) System overload                   | OVERLOAD                      | Red        |
| d) Mains 'on'/battery discharging    | MAINS ON & BATTERY ON LOAD    | Red        |
| e) Low voltage battery disconnection | BATTERY DISCHARGED & ISOLATED | Red        |
| f) Battery / load fuse fail          | FUSE FAIL                     | Red        |
| g) Temperature compensation fail     | TEMP. COMPENSATION FAIL       | Red        |
| h) Battery disconnected from circuit | BATTERY DISCONNECTED          | Red        |

3.10.1.3 All the above indications may be displayed on an LED / LCD type alphanumeric display.

3.10.1.4 All alarm circuits shall be provided with suitable delay to ensure that they do not operate with transients.

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3.10.1.5 All the protection/alarms shall be within tolerance of  $\pm 0.012V$  per cell for voltage and  $\pm 1\%$  in case of current.

3.10.1.6 Every alarm condition shall be accompanied with audio alarm with auto cut off after 120 seconds. Provision shall be made for acknowledgement of stopping the audio alarm.

3.10.1.7 In case of any kind of failure in DSA unit, the SMRs shall switch over to float mode.

### 3.10.2 FRBC/SMR:

3.10.2.1 The following indications, controls & measuring points shall be provided on the front panel of FRBC-

#### A) Status Indication:

| Description                  | Nomenclature | Indication |
|------------------------------|--------------|------------|
| a) FRBC on Auto Float mode   | FLOAT        | Green      |
| b) FRBC on Boost Charge mode | BOOST        | Green      |
| c) Mains available           | MAINS        | Amber      |

#### B) Alarm Indication:

| Description                       | Nomenclature            | Indication |
|-----------------------------------|-------------------------|------------|
| a) Rectifier module over voltage  | OVER VOLTAGE            | Red        |
| b) Rectifier module under-voltage | UNDER VOLTAGE           | Red        |
| c) DC output fail                 | OUTPUT FAIL             | Red        |
| d) FRBC Overload/ short circuit   | OVERLOAD/ SHORT CIRCUIT | Red        |
| e) Fan fail                       | FAN FAIL                | Red        |

Note: "Provision shall be made for stopping the audio alarm with a non-locking push button.

#### C) Control Potentiometers/ through DSA:

- a) Float voltage adjustment (float)
- b) Boost voltage adjustment (boost)
- c) Overload current setting (OL)

D) Voltage monitoring point suitable for measurement by standard multi-meter or through DSA or display on module.

E) Reset button for resetting the alarm as per clause 3.10.2.1

3.10.2.2 All the above indications may be derived on a microprocessor based control and supervisory unit and may be displayed on an LED / LCD type alphanumeric display.

### 3.10.3 INVERTER:

3.10.3.1 The following LED indications shall be provided on front panel:

| Description      | Nomenclature  | Indication |
|------------------|---------------|------------|
| a) Input ON      | Input DC ON   | Amber      |
| b) Output OK     | Output        | Green      |
| c) Inverter fail | Inverter fail | Red        |

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| d) Overload                                       | Overload | Red   |
| e) Inverter 'ON load'                             | On load  | Green |
| f) Fan fail indication(In case of forced cooling) | Fan fail | Red   |

### 3.10.4 DC-DC Converter:

3.10.4.1 The converter shall be provided with means for protection and visual indication on front panel for the following:

| Description                   | Nomenclature | Indication |
|-------------------------------|--------------|------------|
| i) Input Power ON indication  | INPUT        | Amber      |
| ii) DC-DC Converter output OK | OUTPUT       | Green      |
| iii) DC-DC Converter fail     | FAIL         | Red        |

### 3.10.5 AC-AC Converter:

3.10.5.1 The converter shall be provided with means for protection and visual indication on front panel for the following:

| Description                   | Nomenclature | Indication |
|-------------------------------|--------------|------------|
| i) Input Power ON indication  | INPUT        | Amber      |
| ii) AC-AC Converter output OK | OUTPUT       | Green      |
| iii) AC-AC Converter fail     | FAIL         | Red        |
| iv) Overload                  | Overload     | Red        |

**3.11 LIGHTNING & SURGE PROTECTION:** The Lightning and Surge Protection Devices shall be compliant with IEC-61643 (latest) and IEC 62305-4 (latest).

**3.11.1 Stage 1 Protection (at the entry point of input 230V AC supply in the power/equipment room)**

- (a) The Stage 1 protection shall consist of coordinated (Type-1) & (Type-2) type SPDs at the entry point of input 230V AC supply in Power /Equipment room in TT configuration in a separate wall mountable box. The (Type-1) SPD shall be provided between Line to Neutral & Neutral to Earth. They shall be spark gap type voltage switching device and tested as per IEC 61643-11 (latest) with the following characteristics and features-

| SN | Parameters                                                                                | Limits                 |                         |
|----|-------------------------------------------------------------------------------------------|------------------------|-------------------------|
|    |                                                                                           | Between Line & Neutral | Between Neutral & Earth |
| 1  | Nominal Voltage ( $U_n$ )                                                                 | 230V                   | 230V                    |
| 2  | Maximum continuous operating voltage ( $U_c$ )                                            | $\geq 255V$            | $\geq 255V$             |
| 3  | Lightning Impulse current 10/350 $\mu s$ ( $I_{mp}$ )                                     | $\geq 25KA$            | $\geq 50KA$             |
| 4  | Response time ( $T_r$ )                                                                   | $\leq 100 \text{ ns}$  | $\leq 100 \text{ ns}$   |
| 5  | Voltage protection level ( $U_p$ )                                                        | $\leq 1.5 \text{ KV}$  | $\leq 1.5 \text{ KV}$   |
| 6  | Short circuit withstand and follow up current extinguishing capacity without back up fuse | $\geq 10 \text{ KA}$   | $\geq 100A$             |

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|    | ( $I_{sc}$ & $I_{fi}$ )                                         |                                                                                                                                |                             |
| 7  | Temporary Over Voltage ( $U_{Tov}$ ) withstands for 120 minutes | 438V                                                                                                                           | 438V                        |
| 8  | Temporary Over Voltage ( $U_T$ )                                | 334V min. for 05 secs.                                                                                                         | 1200V min. for 200ms        |
| 9  | Operating temperature / RH                                      | - 25°C to +80°C/ 95%                                                                                                           | - 25°C to +80°C/ 95%        |
| 10 | Mounted on                                                      | din rail                                                                                                                       | din rail                    |
| 11 | Indication                                                      | Mandatory                                                                                                                      | Mandatory                   |
| 12 | Plug ability                                                    | Mandatory                                                                                                                      | Mandatory                   |
| 13 | Potential free contact for remote monitoring                    | Mandatory                                                                                                                      | Mandatory                   |
| 14 | Encapsulation                                                   | Encapsulated                                                                                                                   | Encapsulated                |
| 15 | Degree of protection                                            | IP20                                                                                                                           | IP20                        |
| 16 | Housing                                                         | Fire retardant as per UL 94                                                                                                    | Fire retardant as per UL 94 |
| 17 | Approvals as per IEC- 61643-11-2011                             | National/ International Labs like KEMA,VDE etc. or any other accredited test lab (Details of accreditation shall be submitted) |                             |

- (b) The (Type-1) SPD will be followed by (Type-2) SPD adjacent to it and connected between Line & Neutral. The device shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device, thermal disconnecting type and shall be tested as per IEC 61643-11 (latest) with the following characteristics and features-

| SN | Parameters                                                      | Limits (between Line & neutral)                              |
|----|-----------------------------------------------------------------|--------------------------------------------------------------|
| 1  | Nominal Voltage ( $U_n$ )                                       | 230V                                                         |
| 2  | Maximum continuous operating voltage ( $U_c$ )                  | $\geq 253$ V                                                 |
| 3  | Temporary Over Voltage ( $U_{Tov}$ ) withstands for 120 minutes | 438V                                                         |
| 4  | Nominal discharge current 8/20 $\mu$ s ( $I_n$ )                | $\geq 10$ KA                                                 |
| 5  | Maximum discharge current 8/20 $\mu$ s ( $I_{max}$ )            | $\geq 40$ KA                                                 |
| 6  | Response time ( $T_r$ )                                         | $\leq 25$ ns                                                 |
| 7  | Voltage protection level ( $U_p$ )                              | $\leq 1.5$ KV                                                |
| 8  | Operating temperature / RH                                      | - 25°C to +80°C/ 95%                                         |
| 10 | Mounted on                                                      | Din rail                                                     |
| 11 | Indication                                                      | Mandatory                                                    |
| 12 | Plug ability                                                    | Mandatory                                                    |
| 13 | Potential free contact for remote monitoring                    | Mandatory                                                    |
| 14 | Degree of protection                                            | IP20                                                         |
| 15 | Housing                                                         | Fire retardant as per UL 94                                  |
| 16 | Approvals as per IEC- 61643-11-2011                             | National/ International Labs like KEMA,VDE etc. or any other |

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|  |  | accredited test lab (Details of accreditation shall be submitted) |
|--|--|-------------------------------------------------------------------|

- (c) (Type 1) and (Type 2) SPDs of Stage I shall be so coordinated that the voltage protection level of the coordinated devices is  $\leq 1.5$  KV. As such, these devices shall be from the same manufacturer and necessary test certificate in this regard shall be submitted by the manufacturer/ supplier.

### 3.11.2 Stage 2 Protection (at the output side inside the distribution panel)

The Stage 2 protection shall consist of (Type 2) SPDs for  $\geq 24$ V-110V AC/DC supplies at the output side inside the rack of IPS. These shall be provided for External circuits i.e. Relay external circuit, Axle counter circuit, point machine circuit, AC-AC converters, Inverter output and output of any other modules which are directly connected to external circuits. The (Type 2) SPD shall be a single compact varistor of proper rating and in no case a number of varistors shall be provided in parallel. It shall be voltage clamping device and thermal disconnecting type. They shall be tested as per IEC 61643-11-2011 with the following characteristics and features-

| SN | Parameters                                           | Limits (between L1 & L2, L1 & E , L2 & E)                                                                                      |                                   |
|----|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| 1  | Nominal Voltage ( $U_0$ )                            | 60V-110V AC/DC                                                                                                                 | 24V-60V AC/DC                     |
| 2  | Maximum continuous operating voltage ( $U_c$ )       | $\geq 150$ (AC)<br>$\geq 200$ (DC)                                                                                             | $\geq 75$ (AC)<br>$\geq 100$ (DC) |
| 3  | Nominal discharge current 8/20 $\mu$ s ( $I_n$ )     | $\geq 10$ KA                                                                                                                   | $\geq 10$ KA                      |
| 4  | Maximum discharge current 8/20 $\mu$ s ( $I_{max}$ ) | $\geq 40$ KA                                                                                                                   | $\geq 40$ KA                      |
| 5  | Response time ( $T_r$ )                              | $\leq 25$ ns                                                                                                                   | $\leq 25$ ns                      |
| 6  | Voltage protection level ( $U_p$ )                   | $\leq 1.0$ KV                                                                                                                  | $\leq 0.5$ KV                     |
| 7  | Operating temperature / RH                           | - 25°C to +80°C/ 95%                                                                                                           | - 25°C to +80°C/ 95%              |
| 8  | Mounted on                                           | Din rail                                                                                                                       | Din rail                          |
| 9  | Indication                                           | Mandatory                                                                                                                      | Mandatory                         |
| 10 | Pluggability                                         | Mandatory                                                                                                                      | Mandatory                         |
| 11 | Potential free contact for remote monitoring         | Mandatory                                                                                                                      | Mandatory                         |
| 12 | Degree of protection                                 | IP20                                                                                                                           | IP20                              |
| 13 | Housing                                              | Fire retardant as per UL 94                                                                                                    | Fire retardant as per UL 94       |
| 14 | Approvals as per IEC-61643-11-2011                   | National/ International Labs like KEMA,VDE etc. or any other accredited test lab (Details of accreditation shall be submitted) |                                   |

- 3.11.3 Length of all cable connection from SPDs to earth equi-potential busbar shall be kept less than 0.5mtrs. For this, a sub earth equi-potential busbar shall be installed at approx.

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20cm from the SPD box. The details of connection of SPDs for Stage 1 & 2 of a typical installation with IPS is enclosed as **Annexure-VII**.

### 3.12 POTENTIAL FREE CONTACTS:

3.12.1 Following potential free contacts shall be provided for extension of alarms at remote place:

- a) Inverter 1 fail
- b) Inverter 2 fail
- c) FRBC fail
- d) Transformer fail
- e) DC-DC converter fail
- f) Mains fail
- g) Call S & T staff
- h) Battery low (50% Deep discharge)
- i) SPD fail
- j) AC-AC converter fail

### 3.13 FUSES & CONNECTORS:

3.13.1 All plug-in connectors shall be non-interchangeable. Connectors as per IEC 947 shall be provided.

3.13.2 Fuse holder identification shall include details of fuse rating and type.

3.13.3 All power fuses shall confirm to specification IS 13703 / IS 9224.

### 3.14 NOISE & VIBRATION :

3.14.1 Fully equipped rack at full load shall not contribute more than 15dB (weighted) to the ambient noise level taken as 45dBA. It shall be measured at a distance of 1 meter from the unit and 1.25 meter above the floor level in the full audio range upto 3.4 KHz. The correction factor for total noise when the ambient noise level is more than 45dBA shall be as given below:

| Ambient Noise (dBA) | Correction Factor (dB) | Ambient noise (dBA) | Correction Factor (dB) |
|---------------------|------------------------|---------------------|------------------------|
| 45                  | 0                      | 53                  | 2.07                   |
| 46                  | 0.18                   | 54                  | 2.43                   |
| 47                  | 0.39                   | 55                  | 2.82                   |
| 48                  | 0.61                   | 56                  | 3.25                   |
| 49                  | 0.86                   | 57                  | 3.69                   |
| 50                  | 1.12                   | 58                  | 4.17                   |
| 51                  | 1.41                   | 59                  | 4.68                   |
| 52                  | 1.73                   | 60                  | 5.21                   |

**Note:** The correction factor shall be added to the limit of 60dBA to arrive at the limit when the ambient is greater than 45dBA.

3.14.2 The IPS sub-systems shall be suitably screened and immune to any kind of EMI interference. The sub-system shall not produce any hum in the peripheral devices.

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### 3.15 COMPONENTS:

- 3.15.1 The recommended list of major components and their makes is given in **Annexure-VI**.
- 3.15.2 Semiconductor and other components used in the equipment shall be of industrial grade with min. operating temperature range -25°C to + 85°C. Components shall conform to relevant IS/IEC specification. Resistors and capacitors shall meet relevant provisions of latest RDSO/SPN/144/2006 or latest.

### 3.16 PRINTED CIRCUIT BOARD:

- 3.16.1 Printed Circuit Board shall generally conform to relevant provisions of latest RDSO/SPN/144/2006 or latest for safety & reliability requirement of Electronic signalling equipment.

### 3.17 CABLES & WIRING:

- 3.17.1 All the cables and wires used for wiring and inter connections of modules shall conform to specification No. IRS: S 76-89/IS 694 of grading 1100V. All these cables must be Fire resistive and antirodent type. The colour scheme employed for the rack wiring shall be as below:

AC line : Yellow  
AC neutral : Blue  
Earthing : Green  
DC positive : Red  
DC negative : Black  
Control wiring : Grey

- 3.17.2 All connections shall be made through crimped eyelets and shall be numbered with PVC cable marker rings/ inkjet printing on cables corresponding to the numbers/letters shown in the schematic wiring diagram. Soldering shall be used only where use of crimped eyelets is not possible.
- 3.17.3 All non-current carrying metal parts shall be bonded together and adequately earthed.
- 3.17.4 All wiring shall be neatly secured in position by bunching /strapping & adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be provided with rubber grommets.
- 3.17.5 There shall not be any exposed wiring outside the cabinet.
- 3.17.6 Cables and connectors used for internal wiring and interconnection of modules shall be of highest capacity of approved modules.

### 3.18 MODULE REPLACEMENT TIME AND MTBF:

- 3.18.1 The mean time to replace a faulty module of IPS shall be less than 20 minutes.
- 3.18.2 The designed MTBF of FRBC, Inverter, DC-DC Converter, Supervisory control unit & ASM Panel shall not be less than 35,000 hours.
- 3.18.3 The DC fan provided at rack /module level should have MTBF better than 70,000 hours at 40°C. The fan shall be covered with grill.

### 3.19 RADIO FREQUENCY INTERFERENCE SUPPRESSION:

|                           |                      |                                |               |
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- 3.19.1 The FRBC, Converters (DC-DC, AC-AC)& Inverter shall be designed to minimize the level of Electromagnetic Interference (EMI/RFI), both conducted & radiated, in the vicinity of FRBC. The radiated & conducted noise shall be within the limits specified in International specification no.IEC CISPR 22 'A' or latest. The firm shall submit certificate to this effect from accredited national/international test house at the time of type test.

### 3.20 REMOTE MONITORING:

- 3.20.1 Facility for remote monitoring to be provided as stipulated in FRS of Remote Diagnostic and Predictive Maintenance System (RDPMS) no RDSO/RDPM/FRS/2021 or latest. An arrangement shall be provided to generate notification.

The Fault list for Display &notification shall be as per the following table:.

| No. | Description                                                                       | Indication and alarm at RDPMS |                             |
|-----|-----------------------------------------------------------------------------------|-------------------------------|-----------------------------|
|     |                                                                                   | Nomenclature/SMS Text         | Visual and Alarm Indication |
| 1   | Battery Fail( Battery Low Voltage or Battery Deep discharge or Battery Fuse fail) | BATTERY FL                    | Red                         |
| 2   | Mains fail (Input supply not available, Input supply high, Input supply low)      | I/P MAINS FL                  | Red                         |
| 3   | SMR Fail ( Voltage / Current not available or out of range)                       | SMR FL                        | Red                         |
| 4   | Battery current ( charging and discharging) not available                         | DC FL                         | Red                         |
| 5   | Over Load (AC bus Over load)                                                      | AC BUS O/L                    | Amber                       |
| 6   | Inverter fail                                                                     | INV FL                        | Red                         |
| 7   | AVR/AC-AC converter fail                                                          | AVR/AC-AC FL                  | Red                         |
| 8   | Step down Transformer fail (not required if AC-AC converter provided)             | TX FL                         | Red                         |
| 9   | DC-DC converter fail                                                              | DC-DC FL                      | Red                         |
| 10  | SPD fail                                                                          | SPD FL                        | Red                         |
| 11  | Fan fail                                                                          | FAN FL                        | Red                         |

The IPS vendor shall ensure to provide above information for RDPMS system. However, method for provision may be decided by IPS vendors.

The Remote Monitoring System shall also be capable to monitor the Voltage and Current level of the following components of the IPS and the data shall be stored and communicated through RDPMS Server or any other means defined by Railway.

#### (i) FRBC/SMR Section: -

- Individual SMR voltage and current
- InputAC voltage
- Input AC current
- Total Battery voltage
- Total current (Battery plus Load current)
- Battery current ( charging and discharging)
- Faults of individual modules

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**(ii) AC Section:-**

- Voltage and current of individual Inverter
- Voltage and current of individual Step down Transformer
- Voltage and current of individual AVR
- Voltage and current of individual AC-AC converter
- Faults of individual modules

**(iii) DC Section:-**

- Voltage of each group
- Current of each group
- Faults of module in each group

**3.21 TEST AND REQUIREMENTS:** Manufacturer of IPS shall manufacture a test bench to test the proper functioning of all modules supplied along with IPS. There shall be provision to connect each module individually on test bench to know the healthiness of each module. Necessary arrangement of Display/meters with LED indication may be provided for this purpose on test bench. These test bench shall be supplied as per purchaser requirement separately.

**3.21.1** Inspection & tests shall be carried out to ensure that requirements of this specification are complied. All tests, unless otherwise specified, shall be carried out at ambient atmospheric conditions on all the modules of SMPS based IPS system. For inspection of material, relevant clauses of IRS: S 23 and RDSO/SPN/144/2006 or latest shall apply unless otherwise specified.

**3.21.2 Initial Type approval:**

Manufacturer shall furnish following information at the time of initial type approval of IPS system-

- a) Details of protection provided and their effectiveness / proposed set values and range and working principle.
- b) Bill of material for racks and modules. Details of semi conductors devices used and its specification and data sheets.
- c) Safety margins in voltage, current, thermal (for junction temperature) along with the limit value for power devices, inductors and transformer etc.
- d) Installation & commissioning manual, Quality Assurance Plan and Service manual (consisting of indications and fault diagnostics, Do's & Dont's etc.)
- e) Design approach for the IPS system and salient features through which required MTBF has been achieved.

**3.21.3** While granting initial type approval, it shall be ensured that the system conforms to all the clauses and passes all type tests as mentioned in clause 3.21.6 and other relevant guidelines of RDSO.

**3.21.4** In case of design changes, RDSO may call for fresh sample in the intermediate stage. In such cases, manufacturers shall submit all the information as per clause 3.21.2.

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### 3.21.5 **Quality Audit for Extension of Approval:**

Further extension of approval may be accorded as per latest guideline mentioned in concerned apex documents issued by RDSO.

### 3.21.6 The following shall comprise the **Type Tests**:

- a) Visual Inspection (Cl. 3.22.1)
- b) Insulation Resistance (Cl. 3.22.2)
- c) Applied high voltage test (Cl. 3.22.3)
- d) Temperature rise test (Cl. 3.22.4)
- e) Performance test (Cl. 3.22.5)
- f) Test for protective devices (Cl. 3.22.6)
- g) Environmental & Climatic Test (Cl. 3.22.7)
- h) Functional test (Cl. 3.22.8)
- i) Vibration test on modules as per RDSO/SPN/144/2006 or latest or IS : 9001 Pt. XIII.
- j) Static discharge test as per RDSO/SPN/144/2006 or latest. Electrostatic discharge test shall be carried out as per international standard IEC 61000-4-2 or its equivalent with 150 Pico Farad charged capacitor of 7KV and should be discharged through 330 ohm resistor.
- k) Induced High Voltage Test for Step Down Transformer.(Cl.3.3.3.16)

**Note:** (i) Test for protective devices and performance test shall be carried out before and after climatic test. There shall not be any significant deviations in the observations recorded.

(ii) Vibration & Static discharge test shall be conducted on one module of FRBC along with DSA unit, ASM panel, Inverter, DC-DC and AC-AC Converter.

### 3.21.7 The following shall comprise the **Acceptance Test**:

The acceptance test shall be carried out as per the sampling plan given in Clause in 11.0.

- a) Visual Inspection (Cl. 3.22.1)
- b) Insulation Resistance (Cl. 3.22.2)
- c) Applied high voltage test (Cl. 3.22.3)
- d) Temperature rise test (Cl. 3.22.4)
- e) Performance test (Cl. 3.22.5)
- f) Test for protective devices (Cl. 3.22.6)
- g) Functional test (Cl. 3.22.8)

### 3.21.8 The following shall comprise the **Routine Test**:

The routine test shall be carried out on every module of the IPS system and the results will be submitted by the manufacturer to the inspecting authority at the time of inspection.

- a) Visual Inspection (Cl. 3.22.1)
- b) Insulation Resistance (Cl. 3.22.2)
- c) Applied high voltage test (Cl. 3.22.3)
- d) Performance test (Cl. 3.22.5)
- e) Test for protective devices (Cl. 3.22.6)
- f) Functional test (Cl. 3.22.8)

### 3.21.9 **Requirement of Prototype Sample For Type Test:**

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The manufacturer shall submit a SMPS based IPS for type test considering highest capacity of each module in N+1 configuration as per **Annexure IIIA** with Single SM panel and approved type batteries.

### 3.22 TEST PROCEDURE: (Approved Test formats will be issued Time to Time separately)

#### 3.22.1 Visual Inspection

Test for visual inspection shall be carried out as per relevant clauses of this specification and RDSO/SPN/144/2006 or latest.

#### 3.22.2 Insulation Resistance

Insulation resistance (I.R) test shall be carried out:

- before the high voltage test
- after the high voltage test
- after climatic test

The measurement shall be made at a potential of not less than 500 V DC. The insulation resistance shall be measured at module level / rack as follows:

- Input line terminals and the body of the equipment
- Output line terminals and the body of the equipment
- Input line terminals and output line terminals
- Between rack and earth

Value of the insulation resistance shall not be less than 10 M.ohm for the rack / equipment and 1000 M.ohm for the Transformer/CVT when measured at a temperature of 40°C and relative humidity of 60%. There shall not be appreciable change in the values measured before and after high voltage test and after the temperature rise test.

After completion of climatic test, the values shall not be less than 5 M.ohm for the equipment and 500 M.ohm for the Transformer/CVT when measured at a temperature of 40°C and relative humidity of 60%.

**Note:** - In case, temperature and humidity prevalent at the time of the above measurements of insulation resistance are different from those specified above, the values of I.R. shall be obtained from the table given below-

| R.H  | 25°C        | 30°C        | 35°C        | 40°C        |
|------|-------------|-------------|-------------|-------------|
| 60%  | >100 M.ohms | >100 M.ohms | >100 M.ohms | >100 M.ohms |
| 65%  | 100 M.ohms  | 90 M.ohms   | 85 M.ohms   | 80 M.ohms   |
| 70%  | 80 M.ohms   | 70 M.ohms   | 65 M.ohms   | 60 M.ohms   |
| 75%  | 60 M.ohms   | 53 M.ohms   | 47 M.ohms   | 43 M.ohms   |
| 80%  | 42 M.ohms   | 36 M.ohms   | 33 M.ohms   | 30 M.ohms   |
| 85%  | 29 M.ohms   | 25 M.ohms   | 22 M.ohms   | 18 M.ohms   |
| 90%  | 20 M.ohms   | 16 M.ohms   | 13 M.ohms   | 10 M.ohms   |
| 95%  | 15 M.ohms   | 10 M.ohms   | 7 M.ohms    | 5 M.ohms    |
| 100% | 10 M.ohms   | 6 M.ohms    | 3 M.ohms    | 1 M.ohms    |

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### 3.22.3 Applied High Voltage Test

The module shall withstand the application of 2000 V AC rms for one minute without puncture and arching. The test voltage shall be approximately sine wave and of any frequency between 50 and 100 Hz. The high voltage shall be applied between the following:

- a) Input and earth
- b) Output and earth
- c) Input and output

#### Note:

- i) For FRBC, (b) above shall be tested at 1000V AC rms
- ii) DC-DC Converter shall be tested for a), b) & c) at 1000V AC rms.
- iii) The test shall be carried out after removing surge arrestors /MOVs or any other surge absorbing components.
- iv) In routine test, only one module of each type shall be tested.

### 3.22.4 Temperature Rise Test

3.22.4.1 Temperature rise test should be logged during functional test of IPS after 8 hours, either with the help of thermo-couple or with resistance method on one module of each type.

3.22.4.2 While conducting the test with the help of thermo-couple, the temperature of MOSFET/IGBT, diode, Transformer/ Ferrite Transformer, choke, Internal ambient, Inside cabinet and outside cabinet shall be recorded at every one hour for first four hours and every half hour for next four hours. During this test, the temperature compensation probe shall be disconnected.

3.22.4.3 The temperature rise of heat dissipating components above the ambient measured directly and at heat sink shall not be more than-

- a) Transformer and chokes : 90°C
- b) Thyristors & diodes : 40°C
- c) IGBT/MOSFET : 30°C

### 3.22.5 Performance Test

3.22.5.1 Performance test for FRBC shall include following and other relevant clauses of this specification.

- i) The FRBC shall be tested for its output performance (efficiency, power factor, harmonic distortion, psophometric noise and ripple voltage) at the AC input voltages 150V, 230V and 275V at different load currents by connecting a variable resistance load across the output terminals for the auto float mode and auto boost mode respectively.
- ii) In auto float mode, readings shall be taken for float voltage setting of 2.15 V/cell & 2.25V/cell for low maintenance lead acid batteries & VRLA batteries, respectively at load current in the ranges 25% load to full load.
- iii) In auto boost charger mode, readings shall be taken for boost voltage setting of 2.42V/cell & 2.3 V/cell for conventional lead acid batteries & VRLA batteries respectively at load current in the ranges 25% load to full load.

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iv) During the performance test, the system shall fulfil the requirements of efficiency, power factor, psophometric noise, harmonic distortion, ripple voltage etc. as given under clauses 3.2 of this specification.

The test report from National /International test house of RFI/EMI shall be submitted by the manufacturer as per clause 3.19.1.

v) The current sharing of the module working in parallel shall be tested as per clause 3.2.20.2

3.22.5.2 Performance test on DSA unit, Inverter, Ferro Resonant Voltage Regulator, DC-DC Converter, AC-AC converter, and Step down Transformer shall be carried out as per clause no. 3.6, 3.3.1, 3.3.2, 3.4.1, 3.3.4, 3.3.3 & 3.10.

### 3.22.6 Test for protective devices:

3.22.6.1 Test for protective devices for FRBC shall include following and other relevant clauses of this specification.

i) **Short circuit:** During this test, system shall be connected to AC input voltage of 275V. Output terminals shall be short-circuited through a suitable arrangement. Steady short circuit current shall be measured. It should not exceed rated current + 5%. There shall not be any damage to charger. Working of over load/ short circuit indications/ alarms will also be checked on the FRBC. This shall be achieved by controlling output current and voltage under short circuit condition and not by switching off the input/ output voltage under short circuit condition.

ii) **Reverse battery connection:** A fully charged battery shall be connected in reverse polarity to output terminals of charger. There shall be no emission of smoke of undue temperature rise of any component of charger. Working of corresponding indication/ alarm shall also be checked.

iii) Other protection such as over voltage, battery under voltage, battery temperature compensation, battery current limit, input high & low voltage protection test shall be carried out as per detail mentioned in corresponding clause.

3.22.6.2 Test for protective devices for DSA unit, Inverter, Ferro Resonant Voltage Regulator, AC-AC converter, DC-DC Converter and Step Down Transformer shall be carried out as per relevant clause of the specification.

### 3.22.7 Environmental & Climatic Test

3.22.7.1 i) The Environmental & Climatic Tests shall be conducted on complete IPS system in integrated manner. Not more than 2 chambers shall be used for conducting the Tests.

| SN | Test                       | Reference                    | Severity                                                                       |
|----|----------------------------|------------------------------|--------------------------------------------------------------------------------|
| 1  | Change in temperature test | IS: 9000 Part XIV Section II | -10°C to +70°C (as per indoor application of RDSO/SPN/144/2006 (or latest)     |
| 2  | Cold test                  | IS: 9000 Part II Section III | -10°C (as per indoor application of RDSO/SPN/144/2006 (or latest)              |
| 3  | Damp Heat test (Cyclic)    | IS:9000 Part V Section 1 & 2 | Temperature 55° C and other conditions as per RDSO/SPN/144/2006 (or latest)for |

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|   |                     |                              |                                                             |
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|   |                     |                              | indoor application.                                         |
| 4 | Damp Heat (Storage) | IS:9000 Part IV              | As per Indoor applications of RDSO/SPN/144/2006 (or latest) |
| 5 | Dry Heat Test       | IS:9000 Part III Section III | As per Indoor applications of RDSO/SPN/144/2006 (or latest) |

- ii) The climatic tests shall be carried out by setting the system in boost charge mode of operation. During the period of exposure in each test, the system shall be connected to supply mains of nominal input voltage and shall deliver the rated output voltage of 2.3V/ Cell or 2.4V/cell for VRLA/LMLA batteries respectively to a resistive load.
- iii) During the exposure, the system shall be loaded as per load configuration given in clause. 3.21.9 and output of the Signalling transformer/DC-AC inverter module and AC-AC converter module as well as DC-DC Converter shall be monitored at the end of every cycle.

3.22.7.2 Following tests shall be conducted on one module of FRBC, DSA unit, Inverter, Ferro Resonant AVR, DC-DC Converter, AC-AC Converter, Transformer & SM Panel.

| SN | Test           | Reference                   | Severity                                                    |
|----|----------------|-----------------------------|-------------------------------------------------------------|
| 1  | Salt Mist test | IS:9000 Part XI Procedure 3 | As per Indoor applications of RDSO/SPN/144/2006 (or latest) |
| 2  | Dust test      | IS: 9000 Part XII           | As per Indoor applications of RDSO/SPN/144/2006 (or latest) |

3.22.7.3 The performance of modules subjected to above tests shall be observed in IPS system. Vibration Test shall be conducted on FRBC, DSA unit, Inverter, DC-DC Converter, AVR modules, AC-AC converters & Status monitoring Panel unit as per RDSO/SPN/144/2006 (or latest) or IS: 9001 Pt. XIII. The working of modules subjected for vibration test shall be observed with the IPS system.

### 3.22.8 Overall Functioning of IPS

After above tests, overall functioning of IPS shall be checked as follows:

3.22.8.1 All sub systems shall be put on full load and with battery bank connected to the IPS. The overall functioning of IPS shall be observed for 72 hours during type test, 8 hours during acceptance test & 4 hours during routine test with frequent ON and OFF condition of AC Mains alternately, after every 30 minutes.

3.22.8.2 All the sub systems of IPS shall be connected. The output of all sub systems shall be checked. The switching over from mains to standby and vice versa of FRBC, inverters and DC-DC, AC-AC converters shall be checked. Switching over of Inverter & AVR and to AC-AC converter shall also be checked. Indication of working and faulty condition of FRBC, inverters & DC-DC/AC-AC converters shall be checked.

3.22.8.3 All alarms and indications of status monitoring panel shall be checked for its proper functioning.

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### 3.23 SAMPLING PROCEDURE FOR ACCEPTANCE TEST

Visual inspection shall be carried out on one of the IPS unit of each type. The modules shall be tested for insulation resistance, high voltage test, temperature rise test, performance and protection tests as per the sampling plan given below.

| Test Description                                                                                                                                         | Ins. Res. | HV test | Temp rise | Performance Test | Protection Test |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|-----------|------------------|-----------------|
| SMPS (FRBC)                                                                                                                                              | N/2       | N/2     | N/2       | N                | N               |
| Inverter                                                                                                                                                 | N/2       | N/2     | N/2       | N                | N               |
| AVR                                                                                                                                                      | N/2       | N/2     | N/2       | N                | N               |
| DC-DC Converter (of each type/ rating)                                                                                                                   | N/2       | N/2     | **        | N                | N               |
| AC-AC Converter                                                                                                                                          | N/2       | N/2     | **        | N                | N               |
| Transformer                                                                                                                                              | N/2       | N/2     | N/2       | N                | N               |
| Battery Bank -10 hrs discharge test for capacity: Sample shall be taken as per Clause 11.1 of IS: 8320-1982. Cells shall be taken from all banks of IPS. |           |         |           |                  |                 |

\*\* One module of each type/rating

N = Denotes the no. of modules offered for inspection. N/2 shall be rounded off to the next number. In case of any failure during acceptance test, the lot shall be rejected.

### 3.24 EARTHING:

3.24.1 The IPS systems and its individual modules shall have earth terminals and shall be properly earthed to the IPS cabinets.

3.24.2 Zonal Railways shall provide earthing arrangement in conformity to Code of practice for Earthing and Bonding RDSO/SPN/197/2016 (or latest) as per details at **Annexure-VII**.

### 4.0 ADDITIONAL REQUIREMENTS:

#### 4.1 Warranty Clause:

4.1.1 The manufacturer shall submit certificate of the equipment for its satisfactory performance for Four (04) years from the date of supply. Purchaser can ask for extended warranty of Product for additional 04 years (with quarterly visit of authorized person) on additional payment basis. During the warranty/ extended warranty period, any defect should be repaired free of cost.

#### 4.2 Installation & Commissioning:

4.2.1 Installation and commissioning is responsibility of OEM, the same will be carried out by OEM or its authorized representative. For successful commissioning, Installation certificate & Pre-commissioning checklist with Commissioning certificate will only be signed by OEM or its authorized representative.

Authorized representative means, the representative of OEM who has certificate of installation & commissioning issued by OEM with validity period.

OEM shall submit such list of authorized representatives to purchaser along with delivery of IPS.

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### 4.3 Documentation:

- 4.3.1 Two copies of the user's instruction manual shall be supplied along with each IPS unit. The version number shall be clearly indicated on front cover. The manual shall include detailed design of the IPS /modules, dimensional layout drawings, schematic diagrams, and detailed interconnecting drawing of all sub systems. Traceability of interconnection between racks and sub systems shall be ensured. Details on initial checks on receipt at site, testing and adjustment procedures, installation and commissioning procedures, maintenance procedures and detailed trouble shooting chart shall be covered in the manual. All the details in the manual shall be in simple language with trouble shooting explained through suitable pictures/ photographs in step by step manner so that it is well understood by the maintenance staff.
- 4.3.2 The instruction manual is to be prepared using good quality paper with clear crisp printing. All the drawings in clear printing shall be attached to the handbook binding. One set of flow chart drawings necessary for trouble shooting shall be provided with lamination with each manual. The handbook shall have a thick polythene sheet cover with plastic winding or comb winding.
- 4.3.3 The format for joint pre-commissioning checklist and post commissioning load measurements shall be a part of instruction manual. The system shall be commissioned, as per specification and representatives of manufacturer and purchaser/railways shall sign this jointly.
- OEM shall submit a list of authorized representatives for installation & commissioning of IPS, to purchaser.
- 4.3.4 Batch test report of OEM should be submitted by the manufacturer /supplier of Lightning & Surge protection devices to the IPS manufacturer at the time of supply of these devices. Copy of the same shall be submitted by IPS manufacturer to RDSO at the time of acceptance test of IPS system.
- 4.3.5 Semi-conductor power devices and other Solid state components used in IPS shall not be operated at more than 50% of the rated maximum peak voltage and at not more than 50% of the rated maximum average current under any prevailing conditions. Manufacturer shall submit design details, components datasheet at the time of type approval.
- 4.3.6 The manufacturer shall declare the peak reverse voltage, current rating and working temperature of the rectifier element under ambient conditions, the number of elements used and the manner of their connection. The peak reverse voltage rating should not be less than two times the expected reverse voltage across the devices.
- 4.3.7 Aluminum wires shall not be used. The gauge of wiring shall be such that the current density does not exceed 3 amperes/mm square. A data sheet will be submitted by manufacturer.
- 4.3.8 Manufacturers shall give an undertaking regarding use of battery grade acid as per IS 266:1993 and de-mineralized / distilled water as per IS 1069:1993 for initial charging.
- 4.3.9 The equipment shall be so designed that any short/open or any other defect in any of the component will not lead to unsafe / undesirable situation. There shall never be any possibility of unwanted feed to Relays and Signal with variation in temperature, current, voltage, leakage and ageing to unsafe side i.e. in any usual / unusual circumstances. Manufacturer shall submit self declaration at the time of initial approval / any design

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change for compliance of fail-safety validation of IPS system with clearly mentioning about 'any unsafe incidence caused by IPS shall have the responsibility of the Manufacturer'.

#### **4.4 Levelling and Marking:**

- 4.4.1 Each electrical/solid state component should be possible to be located by the layout/circuit drawing. The wiring shall be clearly and permanently identified with a designation or a colour code, which corresponds to the equipment circuit diagram. Where non-standard colours are used, cable functions shall be clearly and permanently labeled at both ends.
- 4.4.2 A screen printed cabling / wiring diagram shall be placed on the inside of the front door or any other convenient place for ready reference of maintenance staff.
- 4.4.3 Screen-printed Do's & Don'ts, adjustment procedures and operating instructions shall be provided at convenient place on front panel of the IPS cabinets. One laminated block diagram shall also be provided at convenient place inside the cabinet.
- 4.4.4 The layout of the components and wiring shall be such that all parts are easily accessible for inspection, repairs and replacement.
- 4.4.5 All markings shall be legible and durable. Where the marking is by use of labels, they shall be metallic or screen-printed. These shall be firmly struck and shall not be capable of being removed by hand easily. They shall be placed in the vicinity of the components to which they refer.
- 4.4.6 All cubicles belonging to one IPS shall be identified with a common serial number.
- 4.4.7 Each cubicle shall be identified with the following appropriate name plates/labels:
- i) SMPSIPS-AC Section
  - ii) SMPSIPS-DC Section
  - iii) SMPSIPS- FRBC Section
- 4.4.8 Each FRBC, Inverter, AVR, DC-DC converter, AC-AC converter, shall be marked with its name & rating on its front panel. The placement for particular module in respective rack shall be clearly marked with its application for the purpose of appropriate replacement.
- 4.4.9 Every SMPS based IPS shall be provided with a rating plate fixed outside at a conspicuous place in IPS cubicle. It shall be clearly and indelibly etched, engraved or screen printed and shall show the following minimum information:
- a) Name and trade mark of the manufacturer
  - b) Specification No.
  - c) Nominal AC input voltage and frequency
  - d) Serial number and year of manufacturing.
  - e) Version number as per RDSO/SPN/144/2006 or latest.
  - f) A QR code based scanning arrangement shall be provided at the time of installation of IPS system consisting all details mentioned in Pre commissioning checklist. It should be verified by the Railway representative during commissioning of IPS.
- 4.4.10 All input and output terminals shall be clearly identified by using proper name tags/labels

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#### 4.5 Indenting Description / Information to be supplied By The Purchaser:

Purchaser will give Indenting description as per his requirement. Based on this, during participation of tender, vendor will submit his drawing to meet the requirement as demanded by purchaser. Inspection will be done as per drawing submitted by Vendor.

##### 4.5.1 Indenting description / information to be supplied by the Purchaser for the IPS system configuration is as under:

“Supply, installation and commissioning of SMPS based integrated power supply system for Station / IBS / LC Gate in non-RE /RE area as per details given below:

| S.No | Details                                                                                                                                                                                                                                                                          | Remarks |                    |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|--------------------|
| 1    | SMPS based integrated power supply system (IPS) suitable for signalling installations without AFTC at Station / IBS / LC Gate (up to 15KVAsignalling load) (Mention any of the above)                                                                                            |         |                    |
| 2    | Total number of SMPS based integrated power supply system (IPS)required with same configuration.                                                                                                                                                                                 |         |                    |
| 3    | RE area/ Non-RE area                                                                                                                                                                                                                                                             |         |                    |
| 4    | Type of Battery (Low Maintenance or VRLA or any other cells approved by RDSO)                                                                                                                                                                                                    |         |                    |
| 5    | Capacity of Battery (120AH / 200AH / 300AH)                                                                                                                                                                                                                                      |         |                    |
| 6    | Requirement of Battery Rack –<br>If yes type of Battery racks (MS) for VRLA batteries. Wooden rack for low maintenance batteries.                                                                                                                                                |         |                    |
| 7    | Distance between IPS Room &Status Monitoring Panel installation Place. (in meters)(vendor will provide cable up to 100 mtr with each IPS)                                                                                                                                        |         |                    |
| 8    | Distance between IPS rack & battery. (in meters)                                                                                                                                                                                                                                 |         |                    |
| 9    | SMPS Charger FRBC Module (N+1)                                                                                                                                                                                                                                                   |         |                    |
| 10   | Required Load in KVA for Track circuit<br>(a) 500 VA X N<br>(b) 1.0 KVA X N<br>(c) 1.5 KVA X N<br><b>Note-</b> N is no of modules required based on load calculation of Track circuit. Purchaser should choose only one option out of the three options (a) or (b) or (c).       |         |                    |
| 11   | Required Load in KVA for Signal lighting<br>(a) 500 VA X N<br>(b) 1.0 KVA X N<br>(c) 1.5 KVA X N<br><b>Note</b> -- N is no of modules required based on load calculation of Signal lighting. Purchaser should choose only one option out of the three options (a) or (b) or (c). |         |                    |
| 12   | Details of DC-DC converters<br><b>Note:</b> Purchaser should write NIL if particular modules are not required. Number of modules shall be chosen considering total system load up to 15 KVA.                                                                                     | Ratings | Numbers of modules |

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|    | Relay Internal (n+2)                                                                                                       | 24-32V/10 A for M to C Relay                          |  |
|    |                                                                                                                            | 60-66V/05 A for M to M Relay                          |  |
|    | Relay External (n+1)                                                                                                       | 24-32V/ 10 A for M to C Relay                         |  |
|    |                                                                                                                            | 60-66V/05 A for M to M Relay                          |  |
|    | Axle Counter (n+1)                                                                                                         | 24-40V/ 10 A                                          |  |
|    | Panel Indication (n+1)                                                                                                     | 12-28V/10 A                                           |  |
|    | Block Local (n+1)                                                                                                          | 12-28V/05 A                                           |  |
|    | HKT & Magneto (n+1)                                                                                                        | 12-28V/01 A                                           |  |
|    | Block Tele (n+1)                                                                                                           | 03-06 V/0.1 A                                         |  |
|    | Block Line (n+1)                                                                                                           | 24-40V/5A or 10 A, may be used for BPAC               |  |
|    |                                                                                                                            | 12-40V/1 A Depending upon type of Block instrument    |  |
|    |                                                                                                                            | 40-100V/1 A Depending upon type of Block instrument   |  |
|    |                                                                                                                            | 100-150 V/1 A Depending upon type of Block instrument |  |
|    | Data Logger (n+1) 02 Numbers(Mandatory)                                                                                    | 24-32V/10 A                                           |  |
|    | Spare Cell (n+1) 03 Numbers (Mandatory)                                                                                    | 02-12V/05 A                                           |  |
|    | VDU (n+1) (Purchaser shall choose either 110V DC termination or 24-32 V modules)                                           | 110 volt DC termination                               |  |
|    |                                                                                                                            | 24-32V/10A                                            |  |
|    | Embedded PC (n+1) (Purchaser shall choose either 110V DC termination or 24-32 V modules)                                   | 110 volt DC termination                               |  |
|    |                                                                                                                            | 24-32 V/10A                                           |  |
|    | AFDAS/RDPMS (n+1)                                                                                                          | 24-32 V/10A                                           |  |
| 13 | Provision of Remote test unit/ IoT device along with sensors for Remote monitoring of Voltage and current of IPS modules . | ( Yes/No)                                             |  |
| 14 | Integration of Remote Test unit with existing RDPMS system.                                                                | Mandatory                                             |  |
| 15 | Requirement of Extended Warranty Period (Numbers of years)                                                                 |                                                       |  |

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#### 4.6 Packing:

- 4.6.1 Complete IPS shall be packed in suitable wooden boxes/crate, strong enough, without additional packing to prevent damage or loss to the unit during transit. Loose space inside the box/crate shall be filled up with suitable packing material.
- 4.6.2 FRBC module, DC-DC converters, AC-AC converters, Inverters, AVRs & Step down Transformers shall be separately packed. These shall be wrapped in bubble sheet and then packed in thermocole boxes and empty space shall be filled with suitable filling material. All modules shall be finally packed in wooden case of sufficient strength so that it can withstand bumps and jerks encountered in a road / rail journey.
- 4.6.3 Each box shall be legibly marked at one end with code numbers, contents. quantity and name of manufacturer/ supplier. The upside shall be indicated with an arrow. Boxes should have standard signages to indicate the correct position and precaution **"Handle with Care"** with necessary instructions.

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## **ANNEXURE-I**

### **DETAILS OF TOOLS IN TOOLKIT WITH IPS**

**Note:-** Every IPS shall be supplied along with tool kit and shall be placed inside the IPS rack in a suitable Bag/Box.

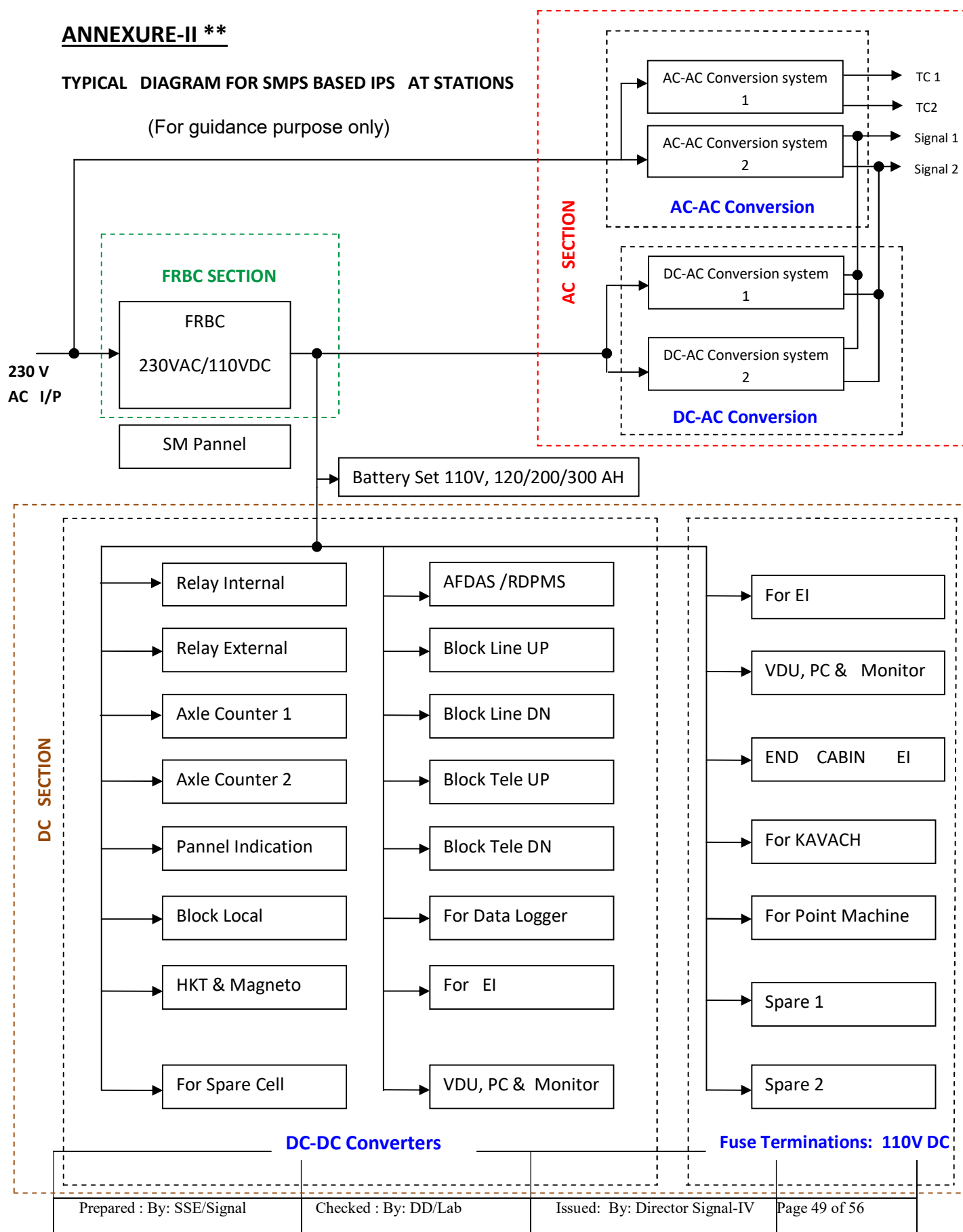
| SN | Description of Tools         | Size                    | Make    | Quantity |
|----|------------------------------|-------------------------|---------|----------|
| 1  | Double ended spanner         | 6-7, 8-9, 10-11 & 12-13 | Taparia | 01 each  |
| 2  | Box spanner                  | 6-7, 8-9, 10-11 & 12-13 | Taparia | 01 each  |
| 3  | Screw driver set (05 pieces) | 6"                      | Taparia | 01 set   |
| 4  | Screw driver small/ aligner  | --                      | Taparia | 01       |
| 5  | Screw driver big             | 12"                     | Taparia | 01       |
| 6  | Cutting plier                | 6"                      | Taparia | 01       |
| 7  | Nose plier                   | 6"                      | Taparia | 01       |
| 8  | Plier                        | 6"                      | Taparia | 01       |
| 9  | Adjustable Torque wrench     | -                       | Taparia | 01       |

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## ANNEXURE-II \*\*

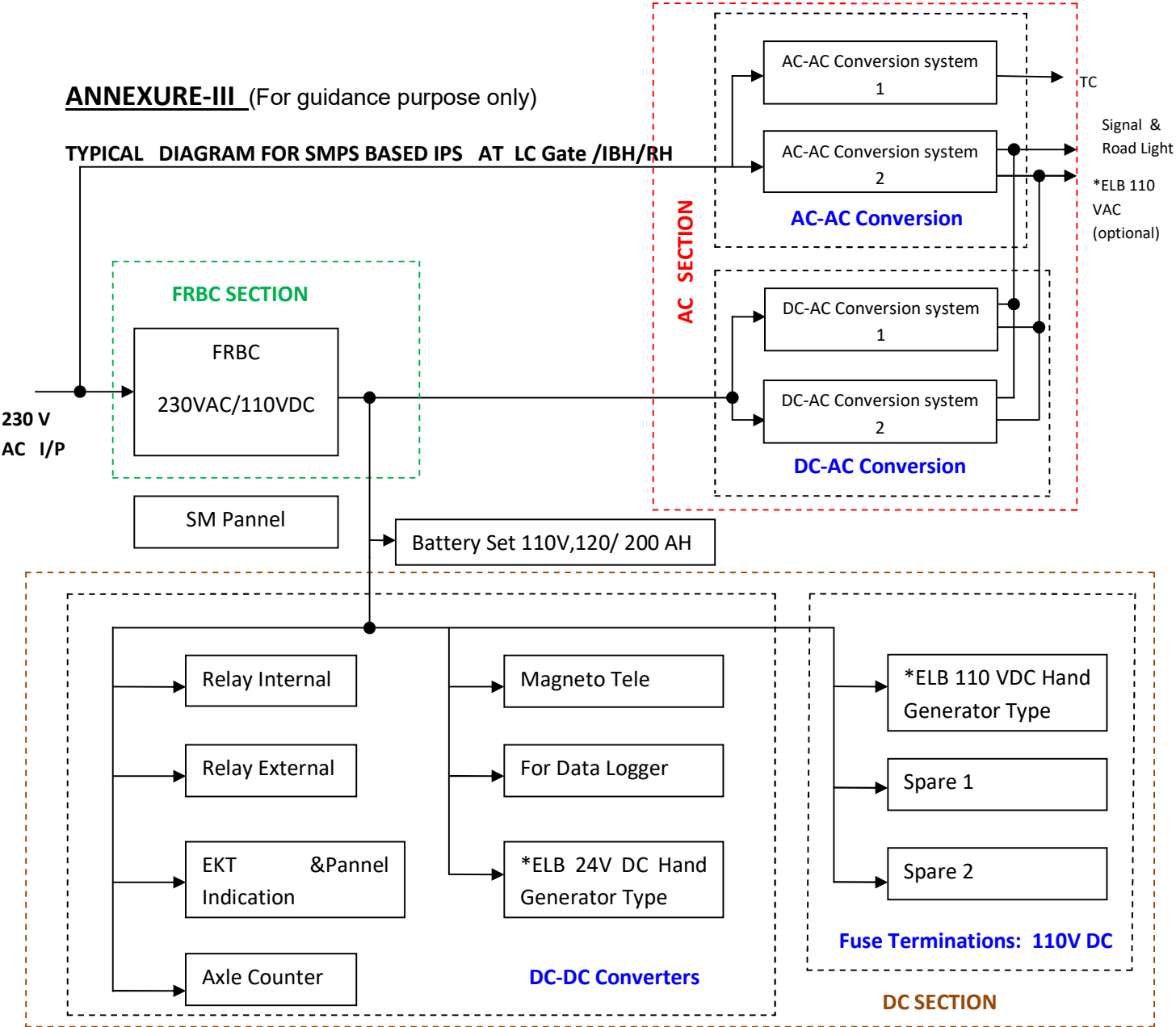
### TYPICAL DIAGRAM FOR SMPS BASED IPS AT STATIONS

(For guidance purpose only)



**ANNEXURE-III** (For guidance purpose only)

**TYPICAL DIAGRAM FOR SMPS BASED IPS AT LC Gate /IBH/RH**



- \*\*NOTE:**
- |                          |                                                                                                                                                                                                                          |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. AC-AC Conversion      | : Conversion from 230V AC input to 110 VAC output shall be achieved either of two methods<br>(a) Using 230VAC/230AC AVR with 230 VAC/110VAC Step Down Transformers<br>(b) 230 VAC/110VAC , AC-AC Converter Modules.      |
| 2. DC-AC Conversion      | : Conversion from 110V DC input to 110 VAC output shall be achieved either of two methods:-<br>(a) Using 110VDC/230AC Inverter with 230 VAC/110VAC Step Down Transformers<br>(b) 110 VDC/110VAC , DC-AC Inverter Modules |
| 3. Step Down Transformer | : Step Down Transformers used for Signal lighting are common for AVR& Inverter (230V AC output) output                                                                                                                   |
| 4. Fuse                  | : Rating of fuses are tentative, This may vary as per 1.5 times of the load requirement                                                                                                                                  |
| 5. *ELB                  | : Only one type of ELB (24VDC/110VDC/110VAC) shall be used                                                                                                                                                               |

|                                                        |                                    |           |                            |
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### DETAILS OF STANDARD MODULES TO BE USED ANNEXURE-III

| S.no | Description & Configuration of Modules                                                                                                       |                         | Rating                                                                                                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.   | FRBC                                                                                                                                         | (n+1)                   | 110VDC/20A                                                                                                                                                                                            |
| 2.   | AC-AC Conversion Section<br>(Combination of Modules<br>viz AVR & , Transformer )<br>OR<br>(AC-AC Converter) modules                          | (n)                     | AVR (230 V AC/230 V AC )- 1 KVA, 1.5 KVA, 2.0 KVA or 3KVA<br><br>Transformer (230 V AC/110 V AC)- 500 VA, 1 KVA,1.5 KVA<br><br>OR<br>AC-AC Converter modules (230 V AC/110 V AC)- 500 VA,1 KVA,1.5KVA |
| 3.   | DC-AC Conversion Section<br>(Inverter with Transformer<br>110VDC to 230 VAC and<br>230VAC to 110 VAC)<br>OR<br>(Inverter 110 VDC to 110 VAC) | (n+1)                   | INV (110 V DC/230 V AC )- 1 KVA, 1.5 KVA, 2.0 KVA or 3KVA<br><br>Transformer (230 V AC/110 V AC)- 500 VA,1 KVA,1.5KVA<br><br>OR<br>Inverter (110 V DC/110 V AC)- 500 VA,1 KVA,1.5KVA                  |
| 4.   | Battery Set                                                                                                                                  | -                       | 110V/120 AH or 200 AH for LC/IBH<br>110V/120 AH, 200 AH or 300 AH at Stations                                                                                                                         |
| 5.   | SM Pannel                                                                                                                                    | -                       | -                                                                                                                                                                                                     |
| 6.   | DC-DC Converters                                                                                                                             | Relay Internal (n+2)    | 60-66 V/ 5 A for M to M Relay<br>24-32V/ 10 A for M to C Relay                                                                                                                                        |
|      |                                                                                                                                              | Relay External (n+1)    | 60-66 V/ 5 A for M to M Relay<br>24-32V/ 10 A, 24-40/10 A for M to C Relay                                                                                                                            |
|      |                                                                                                                                              | Axle Counter (n+1)      | 24-40V/10 A                                                                                                                                                                                           |
|      |                                                                                                                                              | Pannel Indication (n+1) | 12-28V/10 A                                                                                                                                                                                           |
|      |                                                                                                                                              | Block Local (n+1)       | 12-28 V/5 A                                                                                                                                                                                           |
|      |                                                                                                                                              | HKT & Magneto (n+1)     | 12-28 V/1 A                                                                                                                                                                                           |
|      |                                                                                                                                              | Block Line (n+1)        | 24-40V/5A or 10 A, may be used for BPAC<br>12-40V/1 A or 40-100V/1 A or 100-150 V/1 A<br>Depending upon type of Block instrument                                                                      |
|      |                                                                                                                                              | Block Tele (n+1)        | 3-6 V/0.1 A                                                                                                                                                                                           |
|      |                                                                                                                                              | Spare Cell (n+1)        | 2-12 V/5A                                                                                                                                                                                             |
|      |                                                                                                                                              | Data Logger (n+1)       | 24-32 V/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | EI (n+1)                | 24-32 V/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | Embedded PC (n+1)       | 24-32 V/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | AFDAS/RDPMS(n+1)        | 24-32 V/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | KAVACH (TCAS) (n+1)     | 110V DC/5A                                                                                                                                                                                            |
| 7.   | Fuse Termination                                                                                                                             | VDU                     | 110V DC/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | EI(n+1)                 | 110V DC/10A                                                                                                                                                                                           |
|      |                                                                                                                                              | Point machine           | 110V DC/20A                                                                                                                                                                                           |
|      |                                                                                                                                              | Spare                   | 110V DC/30A                                                                                                                                                                                           |

**Note:-**(i) Purchaser may decide the no. of modules & its combination depending upon the load of station with maximum limit of 15 KVA on output side .  
(ii) Rating of fuses are tentative, This may vary as per 1.5 times of the load requirement.

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#### **ANNEXURE-IV**

#### **LIST OF SPARES TO BE SUPPLIED WITH IPS**

| <b>SN</b> | <b>Sub system</b>                                     | <b>Spare components</b>                                                                                 | <b>Qty</b>     |
|-----------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------|----------------|
| 1         | FRBC Module                                           | Module (as cold standby)                                                                                | 1 Module       |
| 2         | Inverter Module                                       | 110VDC/230AC Module (as cold standby)<br><br>OR<br>110VDC/110VACModule (as cold standby)                | 1 Module       |
| 3         | DC-DC Converter                                       | DC-DC Converter used for relay internal, relay external and block line or as required by the purchaser. | 1 module each. |
| 4         | AC-AC Converter                                       | 230VAC/110VAC Module (as cold standby) ( With Supply of AC-AC converter modules only)                   | 2 Modules      |
| 5         | Ferro-resonant type Automatic Voltage Regulator (AVR) | AC Capacitor ( With Supply of AVR only)                                                                 | 1 Set          |
| 6         | Fuses                                                 | All type of fuses used in IPS subsystem                                                                 | 1 Set          |
| 7         | Transformer                                           | Module (as cold standby)( With Supply of Transformer only)                                              | 2 Modules      |
| 8         | Fan                                                   | Fan used for INV/SMR/AC-AC conv.                                                                        | 2 Nos.         |
| 9         | Cells                                                 | 2V Cells                                                                                                | 5 Nos.         |

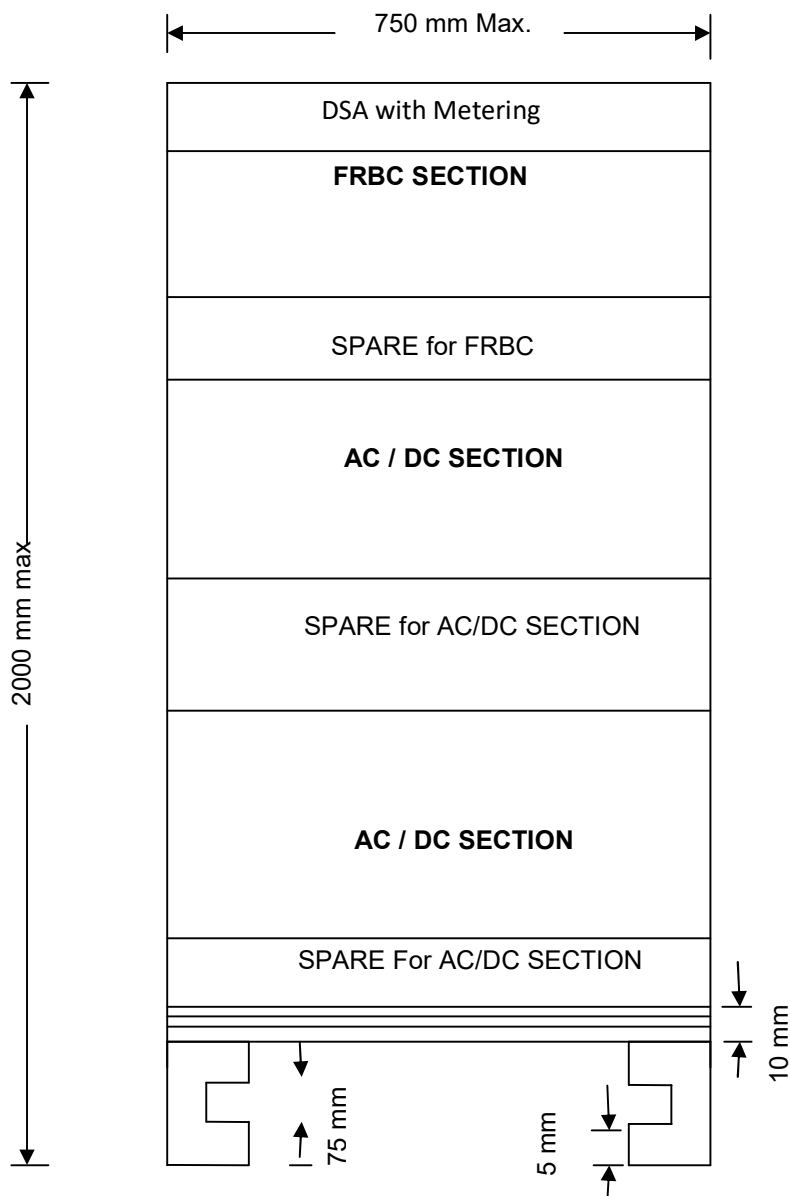
|                           |                      |                                |               |
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## **ANNEXURE-V**

### **LAYOUT OF IPS CABINETS**

(For guidance purpose only)



**NOTE:-** 1. Dimension not to the scale.

2. Overall Dimension of IPS Cabinets:  
2000 mm (Max.)X 750 mm (Max.) X  
750 mm (Max.)

3. If more than one rack are used, the height, and depth of all cabinets shall be equal.

4. If more than one rack are used, all modules of the section must be at one place.

|                           |                      |                                |               |
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## **ANNEXURE-VI**

### **SOURCES OF COMPONENTS OTHER THAN SEMICONDUCTOR DEVICES FOR POWER SUPPLY EQUIPMENTS**

(Annexure to letter no.STS/E/Component dt 24.11.09)

| SN | Item                                                            | Manufacturer                                                                                                                                                                | Country                                                                               | Indian Source                                                                                                                                                                                             |
|----|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | MCB/MCCB                                                        | 1) Schneider Power Electrical)<br>2) Siemens<br>3) Schneider<br>4) ABB<br>5) Indo Asian Fuse Gear<br><br>6) L&T (Hagger brand)<br>7) LegrandIndia<br>8) Havels<br>9) Salzer | India<br><br>India<br>India<br>India<br>India<br><br>India<br>India<br>India<br>India | Authorised dealer<br><br>Authorised dealer<br>Authorised dealer<br>Authorised dealer<br>Indo Asian Fuse Gear, Sonenpath<br><br>L&T, Mumbai<br>LegrandIndia, Mumbai<br>Authorised dealer<br>Coimbatpur T.N |
| 2  | Terminal encapsulated type, DIN rail mounted(only for IPS& ELB) | 1) Phoenix Contact,<br>2) Wago& Control<br>3) Connectwell<br>4) Weidmuller<br>5) ELMEX<br>6) Salzer                                                                         | Germany/India<br><br>Germany/India<br><br>India<br>Germany<br>India<br>India          | Phoenix/New Delhi<br><br>Wago/Noida<br><br>Connectwell/Dombivilli<br>Weidmuller/Pune<br>Elmex electric Pvt.Ltd. Gujrat<br>Coimbatpur T.N                                                                  |
| 3. | DC Contactor                                                    | 1) ABB<br>2) Albright<br>3) Phoenix Contact<br>4) Andrew Yule<br>5) Telemecanique<br>6) Siemens<br>7) Sugi System and controls (Pownix brand)<br>8) L&T<br>9) Salzer        | India<br>UK<br>India<br>India<br>India<br>India<br>India<br><br>India<br>India        | APS Gurgaon<br>Authorised dealer<br>Authorised dealer<br>Authorised dealer<br>Authorised dealer<br>Authorised dealer<br>Sugi System and controls, Bangalore<br><br>L&T, Mumbai<br>Coimbatpur T.N          |
| 4  | AC Contactor                                                    | 1) Telemecanique<br>2) L&T<br>3) ABB<br>4) Siemens<br>5) Salzer                                                                                                             | India<br>India<br>India<br>India<br>India                                             | Authorised dealer<br>L&T, Mumbai<br>Authorised dealer<br>Siemens, Mumbai<br>Coimbatpur T.N                                                                                                                |
| 5. | Capacitors                                                      | 1) Alcon<br>2) CTR<br>3) Epcos AG<br>4) Vishay<br>5) Gujrat Poly- AVX Electronics<br>6) Nippon<br>7) Murata                                                                 | India<br>India<br>India<br>India<br>India<br><br>Germany<br>Germany                   | Alcon, Nasik<br>CTR, Pune<br>Authorised dealer<br>Authorised dealer<br>Gujrat Poly- AVX Electronics Ltd, Pune<br>Authorised dealer<br>Authorised dealer                                                   |

|                           |                      |                                |               |
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|    |                                 |                                                                                                                         |                                                                              |                                                                                                                                                                               |
|----|---------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                 | 8) Desai<br>9) Neotronics (El-Ci-Ar)<br>10) INCAP<br>11) SAMWAHA<br>12) Nichicon                                        | India<br>Japan<br>Japan<br>India<br>India                                    | Desai Engg, Pune<br>Neotronics, Pune<br>Incap Ltd, Vijayawada                                                                                                                 |
| 6. | AC Metal can<br>Capacitor 600 V | 1) Syscap<br>2) Asian<br>3) Epcos AG<br>4) CTR                                                                          | India<br>India<br>IndiaGermany                                               | Syscap<br>Asian, Mumbai<br>Authorised dealer                                                                                                                                  |
| 7. | Resistors                       | 1) Thakor Electronics<br>Ltd<br>2) Baychellog<br>3) PEC<br>4) Watts<br>5) Vishay<br>6) Variturn<br>7) Stead<br>8) Cemet | India<br><br>Germany<br>India<br>India<br>India<br>Germany<br>India<br>India | Thermax, Pune<br><br>Authorised dealer<br>Authorised dealer<br>Watts, Cochin<br>Authorised dealer<br>Variturn Electro Products,<br>Hyderabad<br>Kusum Enterprises, New delhi. |

Note: i) Sources approved as per RDSO's approved list of suppliers for S&T items are automatically approved for the items included therein for use in Power supply equipment.

ii) Sources for various other items already approved and covered in QAP of various firms of Power supply equipment shall continue.

iii) This is recommended list, any approved IPS Vendor may request to add the name of manufacturer for specific item by adding in their QAP as well as the performance report with datasheet of component for proposed item.

|                           |                      |                                |               |
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**ANNEXURE - VII**

**SM ROOM**

AT/COMMERCIAL INPUT SUPPLY

Power (electric) Earth

BLOCK INSTRUMENT

Block earth

BLOCK INSTRUMENT

Block earth

OPERATOR PANEL VDU, EMBEDDED PC (PSA) 110VDC

Block earth

**POWER/EQUIPMENT ROOM**

**STAGE I**

INPUT SPD BOX

63A FUSE

POWER SUPPLY

Type 1 SPD

25X6mm SEEB Cu

20 cm

16 Sq.mm Cu CABLE

Type 2 SPD

10 Sq.mm Cu CABLE

**STAGE II**

IPS (RACK)

FRBC Section

110 V DC

Type 2

AC Section

110 V AC

Type-2

DC Section

OIP > 24 TO 110 V DC

Type-2

OIP > 24 TO 110 V DC

Type 2

TO BUSBAR & P/MC

TO SIGNALS

TO RELAY EXTERNAL

TO AXLE COUNTER

25X6mm SEEB (Cu)

20 cm (approx)

16 Sq.mm Cu CABLE

**E/RELAY ROOM**

EI

10 Sq.mm Cu CABLE

DATALOGGER

10 Sq.mm Cu CABLE

EVALUATOR OF UNIVERSAL AXLE COUNTER

10 Sq.mm Cu CABLE

TO CT RACKS

SEEB (25X6 mm) Cu

Incoming CABLE

MAIN EARTH PIT (EARTH RESISTANCE 1 OHM)

OTHER EARTH PIT

CU TAPE (25X2) mm

TO TELECOM EARTH

PVC INSULATED MULTISTRAND 35 Sq.mm Cu CABLE AS PER IS/5064 (DUPLICATE)

UNDERGROUND

UNDERGROUND

MEEB (25X6 mm) Cu

1. Type 1 & Type 2 SPDs SHALL BE PROVIDED AS PER RDSO SPECIFICATION.

2. ALL THE ARMOURING OF THE CABLES SHALL BE CONNECTED TO SEED.

3. ALL CONNECTIONS FROM EQUIPMENT/SPD TO MEEB/SEEB SHALL BE USING EXOTHERMIC WELDING AT MEEB/SEEB.

1. Type 1 & Type 2 SPDs SHALL BE PROVIDED AS PER RDSO SPECIFICATION.
2. ALL THE ARMOURING OF THE CABLES SHALL BE CONNECTED TO SEED.
3. ALL CONNECTIONS FROM EQUIPMENT/SPD TO MEEB/SEEB SHALL BE USING EXOTHERMIC WELDING AT MEEB/SEEB.