		the bus bars at their respective positions.
g)	Bus bar design	Tinned Copper Busbars shall be provided.
h)	DC Side Negative Grounding	DC side negative grounding system shall be provided for the inverter. The same shall be indicated in the GA/SLD/Schematics and BOM.

4.1.7 AC Output and termination details.

The low voltage AC switchboard shall be rated at the nominal output voltage of the inverter and shall meet the requirements of IEC 61439. The low voltage AC switchboard shall have an insulation voltage of 1000 Vac. The low voltage AC switchboard shall not be of less than 2.0 mm metallic sheet. It shall have a segregation of at least Form 2b. The low voltage AC switchboard shall be free standing with at least front access and bottom entry.

The arrangement of incoming and outgoing ways shall be made in a logical consistent manner taking into consideration speed and safety during installation, operation and maintenance. The fault rating of the main switchboard shall be defined by the vendor for 1 second fully type tested and shall be fitted with air circuit breaker.

Operating handles, locking devices etc. shall be located within the limits of 450 mm and 1900 mm above floor level. The low voltage ac switchboard shall also incorporate On/Off/Trip status indicators on the front panel for all circuits.

Vendor shall supply the inverter with the termination requirements on AC side as tabulated below. General arrangement showing views of termination shall be submitted as part of technical bid. Detailed drawings of termination arrangements with bus bar particulars such as positions, dimensions, hole sizes, spacing between holes, support to bus bar, etc shall be submitted within seven days after receipt of purchase order for BHEL approval.

a)	Number of AC outputs	Three phases: R, Y, B terminals
b)	AC cable entry into panel	Bottom/Top entry. Cable/bus supply shall be in vendor scope. Only copper is allowed. Final details along with sizing calculation shall be submitted by vendor during detailed engineering. Sufficient space shall be provided in the low voltage AC switchboard to cater for the cables to bend and spread from the cable gland plate or bar to the terminals in a logical consistent manner without crossing of cores of a cable or of adjacent cables. Moreover, adequate space shall be provided to facilitate the removal of any cable termination without the need to remove any other termination.

c)	Gland plates	Drilled Gland plates shall be provided with holes to accommodate the cable glands.
d)	Cable glands	Nickel plated brass, double compression type cable glands of reputed make (Make: Comet or any other reputed make) shall be provided by the vendor. Inverters shall be supplied with all glands fixed on the gland plates.
e)	Cable lugs, plain washers, spring washers, bolts and nuts	Cable lugs, bolts, nuts & plain washers, Zinc coated spring washers shall be provided by the vendor. Make for lugs: Dowells or any other reputed make with CE/VDE/UL/CSA/BIS. Inverters shall be supplied with all these items fixed on the bus bars at their respective positions.
f)	Bus bar design	Busbars and busbar connections shall be of high conductivity copper and shall be extensible at both ends. Busbars shall be continuous and of constant cross section throughout their lengths with connections as short and straight as possible. Access to busbars and the busbar connections shall be gained only by the removal of covers secured by bolts and screws. Such covers shall be clearly marked “BUSBARS” along with the short circuit current rating and the fault level at the rated voltage. All neutral bus-bars shall be of the same cross-sectional areas as the associated phase bus-bars. All joints and connections to the bus-bars shall be tin coated the bus-bars and bus-bar supports shall be arranged to withstand, without damage, the effects of any fault current up to and including the maximum rated breaking capacity to the switchboard.
g)	Surge Protective Device	Surge protection device (3P) with suitable rating shall be provided at the input of the ACB. The surge protective device shall be suitable for the PV system in accordance with IEC 60364. The type, the discharge current and the impulse current of the surge protective device for the AC system shall be defined by the vendor and shall be submitted to BHEL for approval. The surge protective device shall feature a local visual status indication and shall incorporate remote contact signalling to indicate normal operating state. In case of surge protective device having the technology combining disconnection and short-circuiting device for safe electrical isolation in event of arcs, the status of the disconnection and short-circuiting device should also be made available remotely.

h)	Indication	Indication for grid side supply ON / OFF status shall be available on the Door Interface.
i)	Measuring Device	Each outgoing section to the dry type transformer shall feature a digital multi-function meter which shall be interfaced with the local SCADA system. All digital multi-function meters shall be flush mounted, include digital displays of the following electrical parameters for all phases: Current (A), Voltage (V), Active Power (kW), Apparent Power (kVA), Reactive Power (kVAr), Kilowatt Hour (kWh), Kilovar Hour (kVArh), frequency (Hz), power factor, harmonic analysis (voltage harmonics, current harmonics, THD) up to the 50th order. All necessary instrument transformers, fuses and wiring, etc., shall be provided by the vendor. The accuracy of the measuring device shall be 0.2.

4.1.8 Panel related parameters

a)	Structure sheets	Doors and frames - Type of enclosure and size/thickness details of the doors and frames shall be indicated by vendor. Gland plate: Minimum 3mm thk min sheet steel or 4 mm thk non-magnetic material
b)	Bus bars	Busbars shall be of appropriate size to match current rating, based on vertical / horizontal layouts and bus bar orientations. Insulation sleeves (PVC etc.) shall be used wherever necessary. Bus bars (both AC and DC) shall be suitably colour coded in accordance with IEC 60446.
	Earthing terminals as per relevant standards	Earthing terminals shall be provided using tinned copper of suitable cross section. Terminals shall be brought out to facilitate external connections.

4.2 Medium Voltage Dry Type Transformer

The dry-type transformer shall comply with IEC 60076, specifically to IEC 60076-11. For the design of the transformer and relevant accessories, the vendor shall refer to the ambient conditions given by IEC 60076-11 and adapt to the site conditions. The dry type transformer shall be air-cooled by means of natural circulation (AN). The dry type transformer shall be explosion-resistant and fire-resistant. Where required by the mounting arrangement on site, anti-vibration pads shall be provided to prevent the transmission of sound to the supporting structure.

The core laminations shall be specially treated to avoid moisture absorption and consequent core corrosion. The primary and secondary coils of the dry type transformer shall be wound separately and encapsulated in cast resin using a vacuum pressure impregnation process. The voltage ratio shall be as detailed in table below.

The dry type transformer shall be capable of withstanding, on any tap position, the thermal and dynamic effects of external short circuit conditions without damage. The value of percentage impedance measured at the mid tap position shall be in accordance with the standard values set out in IEC 60076-11. The transformer short-circuit withstand shall be verified in accordance with 60076-5 and the short circuit withstand time duration shall not be less than 2s.

The transformers shall be designed for operation in over fluxing (as per IEC 60076-11) and over-excitation (as per IEC 60076-1). The transformer shall be designed so that the mechanical and electrical stresses due to the inrush current cannot cause damage and/or rapid aging of the windings, the insulating material or any other parts.

The core of the transformer shall be electrically grounded. Two earthing terminals, each capable of carrying the full lower voltage fault current for a period of not less than 3 s, shall be provided. They shall be located one on either side and near the bottom of the transformer to facilitate connection to the local earthing system.

The transformer environmental, climatic and fire behavior classes shall be chosen in accordance with IEC 60076-11, taking in consideration the transformer ambient conditions and installation criteria. The transformers insulation system shall have temperature class F and the transformer shall be designed for a temperature rise class B (in accordance with IEC 60076-11 and IEC 60076-12).

The enclosure, where applicable, shall be chosen in order to ensure the compliance of the above-mentioned temperature rise, in accordance with the specifications given by IEC 62271-202 Annex DD. The temperature of the core, metallic parts and adjacent materials shall not reach a value that shall cause damage or undue ageing to any part of the transformer.

The measured losses and electrical characteristics of the transformer shall comply with IEC tolerances. In particular, no tolerances shall be applied for sound level and temperature rise limits.

The material used for the magnetic core shall have a low core loss factor and its laminations shall comply with the requirements of IEC 60404. It may be noted that overall losses shall be limited to the value specified in the below table.

The maximum magnetic induction of the transformer shall be chosen to limit local and overall temperature rise of the magnetic circuit.

The windings shall be made of copper. Aluminum is not authorized.

Windings and connections to the bushings and to the tap changers shall withstand mechanical and electro-dynamical stresses caused by handling or short-circuits.

An off-load tap changer shall be provided for the MV/LV.

The transformer shall be fitted with appropriate lifting lugs.

The transformer shall be equipped with all the accessories, instrumentation and protections necessary for easy maintenance and for a safe and reliable operation.

In particular, windings and magnetic core temperature protection shall be provided.

Technical Specifications for Medium Voltage Dry Type Transformer:

a)	Power capacity	2 MVA
b)	Cooling	Natural circulation (AN)
	System frequency	50 Hz
c)	Off circuit tap changer	± 2.5% and ±5%
d)	Medium voltage system short circuit current	At least 25 kA for 1 second
e)	Low voltage system short circuit current	At least 50 kA
f)	High voltage winding	22 kV
g)	Low Voltage winding (open circuit)	As per inverter output voltage
h)	Highest system voltage	24 kV
i)	Power frequency withstand voltage	50 kV
j)	Rated lightning impulse withstand	125 kV
k)	Maximum inverter transformer losses allowed	1.1% (22 kW)
l)	Percentage impedance measured at the principal tap	In accordance with IEC 60076-11

4.3 Dry Type MV Auxiliary Transformer

The auxiliary loads inside the compact station shall be supplied by an auxiliary transformer fed from the solar compact station MV bus bar as per the SLD BHEL-CEB-ELE-001. The transformer shall be protected by MV fuses.

LV nominal system voltage is 400 V. Rated transformer LV voltage (which is the open circuit voltage as defined in IEC 60076) is stated here as 415 V to ensure 400 V at transformer terminals on full load.

Depending on voltage drop in the transformer, this 415 V value may vary slightly to suit the transformer manufacturer's standard design. The 22/0.415 kV common auxiliary transformer shall be properly sized to accommodate the low voltage load of the solar compact station and plus 25%. The final sizing shall be based on load calculations carried out by the vendor and subject to BHEL approval.

Transformers shall comply with IEC 60076. The Auxiliary Transformer shall be dry type transformer in ventilated steel IP 41 enclosures.

Full details of the transformers shall be finalized by the vendor at detailed design stage where calculations shall be submitted to the BHEL for approval.

All alarms and tripping signals for transformers shall be individually connected to the SCADA for control and monitoring.

4.4 Medium Voltage Switchgear for Solar Compact Station

The medium voltage switchgear enclosed in the solar compact station shall be designed for indoor operation on a nominal system voltage of 22 kV, 3-phase, 50 Hz. The medium voltage switchboard shall be modular metal-enclosed high voltage air insulated switchgear manufactured to the requirements of IEC 62271. The switchboard shall fulfill the internal arc classification IAC AFLR, according to IEC 62271-200 and shall have a protection degree of at least IP41 (indoor)

Adjustment of protection settings, inspection of auxiliary circuits and replacement of fuses, lamps and multi-led shall be possible when the relevant feeder is in service. Bus-bars shall have a constant section for the whole switchboard. Phase sequence indication U-V-W-N (if any) shall be marked all over the busbar conductors and on each cable terminations. Each cell of the switchboard shall be divided into busbar, switchgear, MV cable connection and low voltage segregated compartments. “Switchgears” designates circuit breakers, switches.

The medium voltage switchboard shall consist of the following:

- one (1) cubicle designed for the control and protection of the incoming dry type transformer –SCS 1
- one (1) cubicle designed for voltage measurement - SCS 2
- two (2) other cubicles each designed for ring connection with the medium voltage switchboards of the remaining solar compact stations. –SCS 3 & SCS 4
- one (1) cubicle designed for the protection of the auxiliary transformer – SCS 5

The rated current of the three phase bus bars in the medium voltage switchboard shall be defined by the vendor, taking into consideration that the busbars shall be able to carry the full rated current of the Solar PV Farm when all the solar compact stations are ring connected.

4.4.1. SCS 1 - Cubicle for Control and Protection of Incoming Dry Type Transformer
The cubicle shall comprise of at least the following equipment:

4.4.1.1. Three-Position Disconnector

The 3-position disconnector shall be positioned between the circuit-breaker and busbars. The disconnector can only be operated when the circuit breaker is maintained in open position. The 3-position disconnector shall be integral with fault making earth switches and shall be in one of three positions: "closed", "open" or "earthed". Mechanical indicators shall be provided for the switch position on the front facia. Auxiliary contacts shall be provided on the 3-position disconnector to indicate its status to the local SCADA system.

4.4.1.2. Circuit Breaker of SF6 Type

The circuit-breaker shall be of the SF6 type and shall comply with IEC 62271-100. The circuit breaker mechanical and electrical endurances shall be chosen from IEC 62271-100 in accordance with their duty. All circuit-breakers having the same rating shall be identical in arrangement and shall be interchangeable.

The rated current of the circuit breaker shall be defined by the vendor, taking into consideration the current rating of the dry type transformer for the ambient conditions specified. The rated short circuit current AC and DC components of the circuit-breaker shall be chosen in accordance with the results of the short circuit calculation. The minimum short circuit rating for MV switchgears shall be 25 kA, 1s & the minimum short circuit rating for LV switchgears shall be 50 kA, 1s. Any alternative short circuit rating is subjective to BHEL approval only.

The circuit breaker shall operate by means of a motor-operated spring-stored energy system, featuring a rapid acting mechanism, independent of the operator. The motor shall be suitable for 110 Vdc. Mechanical indicator for "charged-discharged" position shall be provided. In the absence of auxiliary power supply, the manual operation of the spring charging system shall be possible. The circuit breaker shall also be equipped with opening, closing and tripping coils suitable for 110 Vdc.

Auxiliary contacts shall be provided on the circuit breaker to indicate its status to the local SCADA system. The circuit breaker shall be equipped with a SF6 pressure switch with two (2) levels of alarms for low pressure and very low pressure respectively.

Mechanical indicators of the circuit breaker position shall be provided on the front fascia. A selector switch shall also be provided for the remote and local operation of the circuit breaker. Push buttons shall be made available on the front fascia of the low voltage compartment for the opening and closing of the circuit breaker. In addition, the following test blocks shall be provided on the front fascia of the circuit breaker cubicle:

- One (1) voltage test block
- One (1) current test block
- One (1) trip test block

4.4.1.3. Current Transformers

The current transformers shall comply with IEC 61869-2 and shall be of the dry type. The current transformers shall be provided for both protective relay and metering purposes.

Toroidal current transformers will not be acceptable for metering purposes. Current transformers with split iron cores will also not be acceptable. The current transformers shall have dual primaries with current rating 100/200 A. The secondary windings of each set of current transformers shall have a rating of 5 A and shall be earthed at one point only, through a bolted disconnecting link.

The maximum continuous rating of the current transformers shall not be less than 150% of the maximum continuous rating of the associated dry type transformer. The current transformers including primary winding conductors shall be capable of withstanding without damage the peak and rated short-time currents of the associated equipment.

The vendor shall perform calculation for the burden, taking into consideration a spare capacity of 20%, to be submitted for approval during detailed engineering.

The rated volt-amp output of the current transformers shall not be less than the connected burden as installed in service, the burden of cable connections being taken into account. The output of the current transformers shall be not less than 10 VA with an accuracy limit factor of not less than 20 and the vendor shall ensure that the capacity of the current transformers provided is adequate for operation of the associated protective devices and instruments.

The current transformers provided for protective relay purposes shall be used for combined overcurrent and earth fault protection of the inverse time-overcurrent type and shall have Class 5P20. The current transformers shall have overcurrent and overcurrent limit factors not less than those corresponding to the design short circuit level of the system. The current transformers provided for metering and instrumentation purposes shall have class 0.2.

The current transformers shall be solidly fixed using appropriate support structures. When double-ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformers, indicating clearly the connections required for each tap. The connections and the ratio in use shall be indicated on all connection diagrams.

Magnetization and core loss curves and dc resistance values shall be submitted for each type and rating of current transformers.

4.4.1.4. Earthing Switch for Cables:

The earthing switch shall be mounted in the cable compartment for cable earthing and shall be of the fault making type. Access to the cable compartment shall only be possible when the circuit is in earthed position. The earthing switch shall be mechanically interlocked with the integral earthing switch of the upstream 3-position switch disconnector, specified in sub-section above.

4.4.1.5. Protection Relay:

The protective relay shall be of approved numerical multi-function type and shall comply generally with the requirements of IEC 60255. The protection relay shall be of the latest technology available, at the time of implementation, incorporating a wide range of protection and control functions as well as comprehensive communication facilities. The system shall be IEC 61850 compatible.

The protection relays shall include full programmable scheme logic, self-diagnostics and time tagged event recording (at least 100 events) to indicate the pre-fault currents and voltages by phase and maximum recorded analogue quantities. The protection relay shall integrate a user-friendly interface for troubleshooting and local programming with password. The protective relay shall be suitable for flush mounting on the front fascia of the LV compartment.

The protective relay shall offer two (2) independent over-current stages for phase elements (I>, I>>) and for earth fault (Io>, Io>>). The I>/Io> elements shall operate when the power frequency component of the current exceeds the set threshold. The time/current characteristic associated with these elements must provide a selection of inverse definite minimum time (IDMT) curves, or be settable to a fixed (definite) time delay. The relay shall be provided with a start function (and programmable relay output) that responds to the current exceeding either I> or Io> thresholds.

In addition, the relay shall have Neutral Voltage Displacement protection functionality.

The auxiliary power supply (in scope of vendor) for protective relays shall be 110V dc. All protective relays supplied shall be tested on site. Proper facility shall be provided for the testing of protective relays and associated circuits. In case, injection test plugs are required for this purpose, the vendor shall provide them.

The vendor shall be responsible for providing to BHEL relay setting details for relays within his supply correctly coordinated with relays of other systems, where applicable.

The vendor shall provide the associated documentation, programming software and communication cables as part of his scope of supply. A communications menu system shall be provided in accordance with IEC 60870. A hard copy as well as a soft copy of the relay configuration, settings and manuals shall be submitted to BHEL before commissioning.

4.4.1.6. Voltage Presence Indicators

The switchgear cubicle shall be equipped with voltage presence indicators according to IEC 62271-206. The voltage presence indicators shall allow the visualization of voltage presence on each phase with LED indication.

4.4.2. SCS 2 - Cubicle for Voltage Measurement

The cubicle for Voltage Measurement shall comprise of the following equipment:

4.4.2.1. 3-position disconnector:

The 3-position disconnector shall be positioned between the DIN fuses and busbars. The 3-position disconnector shall be integral with fault making earth switches and shall be in one of three positions: “closed”, “open” or “earthed”. Mechanical indicators shall be provided for the switch position on the front fascia. Auxiliary contacts shall be provided on the 3-position disconnector to indicate its status to the local SCADA system.

4.4.2.2. Medium voltage fuses

The medium voltage fuses shall be of the DIN type featuring striker pins, suitable for the protection of the MV/ LV transformer for auxiliaries. The rated voltage of the fuses shall be 24 kV. The rated current and the rated breaking capacity of the fuses shall be determined by the vendor based on the rating of the MV/LV transformer for auxiliaries. The mechanical signaling and auxiliary contacts for blown fuses shall be provided.

4.4.2.3. Voltage transformers

The voltage transformers shall comply with IEC 61869-3 and shall be of the dry type. The three (3) voltage transformers shall be single-phase with dual core secondaries for metering and protection. The metering core shall have an accuracy Class 0.2 and rated burden of not less than 10VA. The protection core shall have an accuracy class of 3P a rated burden of not less than 15 VA. A spare burden capacity of 20% in the calculation for future use.

The primary windings shall be connected through DIN fuses featuring striker pins. The mechanical signaling and auxiliary contacts for blown fuses shall be provided. Access to the fuses shall only be possible when both its sides are effectively earthed. Proper interlocking should be provided between upstream 3-position disconnector and the downstream control and protection device on the secondary side of the voltage transformers to prevent power infeed from the secondary side of the voltage transformer.

The voltage transformer secondary circuits shall be earthed at one point only and metal cases shall be separately earthed. Secondary protection (fuses and miniature circuit breakers) shall be provided as close as possible to each voltage transformer and labelled to show their function and phase color. Auxiliary contact shall be provided for the status of the secondary equipment.

Voltage transformers shall be designed so that saturation of their cores does not occur when 1.732 times normal voltage is applied to each winding. The standard secondary voltage between phases shall be 110 V ac. Secondary circuits shall not be connected in parallel.

Calculations for voltage transformer design shall be submitted to BHEL for approval.

4.4.2.4. Voltage presence indicator

The switchgear cubicle shall be equipped with voltage presence indicators according to IEC 62271-206. The voltage presence indicators shall allow the visualization of voltage presence on each phase with LED indication.

4.4.3. SCS 3 & SCS 4 - Cubicle for Ring Connection

The cubicle for ring connection shall comprise of the following equipment:

4.4.3.1. Switch Disconnector

The switch disconnector shall comply with IEC 62271-102 and should be fully insulated by SF6 gas. The switch disconnector shall be triple pole with integral fault making earth switch. The rated current of the switch disconnector shall be defined by the vendor, taking into consideration that the switch disconnector shall be able to carry and break the full rated current of the Solar PV Farm when all the solar compact stations are ring connected. The switch disconnector shall be capable of making on to a fault whose magnitude is equal to the specified short circuit level for 1 second.

The switch disconnector shall operate by means of a motor-operated spring-stored energy system, featuring a rapid acting mechanism, independent of the operator. The motor shall be suitable for 110 Vdc. Mechanical indicator for "charged-discharged" position shall be provided. In the absence of auxiliary power supply, the manual operation of the spring charging system shall be possible. The switch disconnector shall also be equipped with closing and opening coils suitable for 110 Vdc.

Auxiliary contacts shall be provided on the switch disconnector to indicate its status to the local SCADA system. The switch disconnector shall be equipped with a SF6 pressure switch with two (2) levels of alarms for low pressure and very low pressure respectively.

Mechanical indicators of the switch disconnector position shall be provided on the front fascia. A selector switch shall also be provided for the remote and local operation of the switch disconnector. Push buttons shall be made available on the front fascia of the low voltage compartment for the opening and closing of the switch disconnector.

4.4.3.2. Voltage Presence Indicator

The switchgear cubicle shall be equipped with voltage presence indicators according to IEC 62271-206. The voltage presence indicators shall allow the visualization of voltage presence on each phase with LED indication.

4.4.4. SCS5 - Cubicle for the Control and Protection of a MV Transformer for Auxiliaries

The cubicle for Control and Protection of a MV Transformer for Auxiliaries shall comprise of the following equipment:

- 3-position disconnector
- medium voltage fuses
- voltage presence indicator

4.4.4.1. 3-Position Disconnector

The 3-position disconnector shall be positioned between the DIN fuses and busbars. The 3-position disconnector shall be integral with fault making earth switches and shall be in one of three positions: "closed", "open" or "earthed". Mechanical indicators shall be provided for the switch position on the front facia. Auxiliary contacts shall be provided on the 3-position disconnector to indicate its status to the local SCADA system.

4.4.4.2. Medium Voltage Fuses

The medium voltage fuses shall be of the DIN type featuring striker pins, suitable for the protection of the MV transformer for auxiliaries. The rated voltage of the fuses shall be 24 kV. The rated current and the rated breaking capacity of the fuses shall be determined by the vendor based on the rating of the MV transformer for auxiliaries. The mechanical signaling and auxiliary contacts for blown fuses shall be provided for status display on the local SCADA System

4.4.4.3. Voltage Presence Indicators

The switchgear cubicle shall be equipped with voltage presence indicators according to IEC 62271-206. The voltage presence indicators shall allow the visualization of voltage presence on each phase with LED indication.

4.4.6. Insulation Levels and Clearances

The withstand impulse level of switchgear and equipment when tested in accordance with IEC recommendations shall be not less than that specified.
All clearances on equipment, which has not been impulse tested, and the creepage distance across all insulators, shall comply with IEC 62271-100 for circuit breakers.

4.4.7. Temperature Rise

Each current carrying component of the equipment supplied shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the appropriate IEC recommendations without assistance from any forced cooled ventilation or air conditioning plant.

Vendor shall state in the technical particulars, any permissible overload rating for the switchgear operating under emergency conditions, indicating the period of time permissible for the overload and the maximum ambient air temperature.

4.5 Auxiliary equipment:

4.5.1 UPS & AC to DC converter:

Essential a.c. supplies shall be provided from a uninterruptible power supply unit (UPS) through AC Distribution Board (UPSDB). Each UPS shall feed a 230 V a.c. switchboard for distribution to essential systems. UPS system shall include a static bypass switch and an external maintenance bypass switch.
UPS systems shall be full on-line double conversion type and shall comply with IEC 62040 and IEEE 944.The UPS shall have at least adequate capacity for a minimum of 3hrs autonomy at full load and battery life of at least 7 years.

The UPS must have modular architectures based on identical power modules which can be interchanged and connected in parallel, inside the UPS cabinet. Similarly, also batteries must be contained in battery modules (battery drawers) identical and interchangeable. Power modules shall be equipped with control and self-diagnostic circuits, in order to easily individuate the faulty module and the specific failure inside it.

UPS system shall be installed in the solar compact stations catering to the minimum loads of MV Switchgear, SCADA, PLC, fire alarms and essential loads.

In a redundant configuration, if one module fails all the others ones will take the relevant load without any interruptions or transfer time at the output of the UPS.

The modularity of the UPS must allow the increase of the back-up time on site, simply by adding battery drawers.

Each Power Module will be composed by inverter, booster, battery charger, rectifier/PFC and automatic bypass.

The hermetic, maintenance-free stationary Nickel-Cadium batteries are housed in the UPS and/or in one of more cabinets of the same shape and size as that of the UPS itself. The positive and negative battery connections are protected by an adequate fuse-holder isolating switch.

The Command board must be equipped with microprocessor of suitable computation power. This command board must manage all functions of the UPS and will execute the following jobs:

- automatic recognition of the number of connected modules;
- automatic setting of the maximum reactive power that can be provided on the output;
- individual serial communication with the power modules by a dedicated line;
- recognition of a faulty module and diagnosis of the relevant fault;
- synchronization of the output voltage with the input voltage;
- generation of a reference sinewave curve to form the output voltage wave;
- control of the PFC, inverter and booster circuits in each power module;
- management of the automatic bypass;
- management of the battery runtime;
- management and recognition of the signals and measurements from each module;
- management of the user interface;
- management and memorizing of UPS history parameters and data;
- alarm and events memory with association of the time and date of the events themselves.

110V d.c. system shall be derived from the 230 V ac system using a set of three converters from 110V dc to 230V a.c. arranged such that they operate in parallel and each is operating at no more than 33% of its rated capacity. In the event of failure of two converters, the remaining one shall be rated to carry the full load.

An essential service AC distribution switchboard shall be incorporated in the cubicle for the UPS system. A manual bypass switch shall be provided to enable isolation of the UPS for maintenance. UPSDB shall have required number of breakers for feeding to emergency loads.

The 110 V DC distribution switchboards boards shall feature properly sized circuit breakers for the control and protection of the incoming and outgoing feeders. The DC distribution switchboards boards shall also be equipped with surge and lightning arresters.

Distribution switchboards shall be type tested in accordance with IEC 61439 and IEC 60947. Type test certificates shall be sufficient to meet this requirement.

Proper measuring device shall be provided to indicate the d.c. system voltage on each distribution busbar section.

The following alarm devices shall be provided on the d.c. distribution switchboard:

- Undervoltage detection equipment, to give local indication and remote alarm when the system voltage falls below 80% (adjustable) of the rated system voltage. A time delay shall be incorporated to prevent initiation during temporary voltage drops caused by transient conditions including circuit breaker closing operations.
- Earth leakage detection equipment on each busbar to give local indication and remote alarm of the occurrence of an earth fault and to give discrimination between positive pole and negative pole earth faults. Test circuits shall be incorporated to simulate positive and negative faults by operation of test pushbuttons.
- Alarms for the distribution switchboard shall be grouped to give remote alarms on the local SCADA.

4.5.2 ACDB:

Distribution boards shall be provided as required for local 400/230 Vac distribution of lighting and small power (sockets). The lighting and small power circuits may use a common distribution board. They shall be fitted with the appropriate number and rating of circuit breakers, RCD's, distribution blocks, earth bars, neutral bars, etc. Electrical drawings shall be submitted for the LV Distribution board to the Engineer/Employer, prior to ordering of panel and equipment.

Each low voltage switchboard shall be of the single-busbar, built assembly type, in accordance with IEC 60439, IEC 61439 and MS 63.

ACDB shall have incomers fed from the auxiliary transformer located within the container.

The distribution switchboards shall include for the provision of the required number of circuit breakers plus at least two spare breaker and 30% spare space shall be provided.

Busbars shall be of constant cross section copper throughout. Output feeders in ACDB shall be meeting all the auxiliary load requirement of the SCS**.** However, final feeder list shall be provided during detailed engineering. Each compartment of the solar station container shall also be equipped with at least two small power installation (socket outlets).

In case auxiliary supply of PCU is met internally, then it should have sufficient power backup to meet the LVRT requirement. Vendor shall submit the detailed auxiliary supply arrangement during detailed engineering stage.

4.5.3 Lighting Design