material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

5.13.10.2 STANDARDS

The equipment covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 1651	Stationary cells & batteries, lead acid type (with tubular positive plates)
2	IS: 266	Battery grade Sulphuric Acid. (Battery electrolyte)
3	IS: 1069	Water for storage batteries
4	IS: 1146	Rubber & Plastic containers for lead Acid storage batteries
5	IS: 1248	Electrical Indicating Instruments
6	IS: 13947	Low voltage switchgear and control gear
7	IS: 3895	Mono-crystalline semi-conductor rectifier cells & stacks
8	IS: 8320	General requirement and methods of tests for lead acid storage batteries
9	IS : 6071	Synthetic separators for lead acid batteries
10	IS : 8623	Factory built assemblies of switchyard and control gear for voltage up to including 1000 V AC and 1200 V DC (Part 1 to 3)
11	IS : 4540	Non-crystalline semi-conductor rectifier assemblies & equipment

Equipment meeting any other authoritative national or international standards that ensure equal or better quality than the standards mentioned above are also acceptable. Where the equipment conforms to any other standards than those mentioned above, salient points of difference between the standards adopted and standards mentioned above shall be brought out in the tender.

5.13.10.3 GENERAL REQUIREMENTS

Minimum general requirements for the DC Battery, Battery charger and DC Distribution Board are mentioned below.

- Lead acid tubular type battery of required rating shall be provided at Main Control Room and each Local Control room. Battery Bank at Main Control Room shall be 220 V and Battery Bank at Local Control Rooms shall be

selected based on the Control Voltage required for closing and tripping of 33 kV Indoor type VCBs. 10 hours continuous discharge shall be considered for sizing the battery.

- One float charger and one float cum boost chargers shall be provided to maintain constant voltage at D.C. bus bars while supplying the continuous load in addition to keeping the battery on float charge.
- In case of sudden D.C. requirements due to failure of A.C. supply or charger itself, the battery shall be capable of meeting the system load demand. In case of failure of float charger supplying the continuous DC load, the affected battery charger shall get disconnected automatically from the DCDB and the complete D.C. load requirements shall be met by the float charger of float cum boost charger unit.
- The charger shall be protected against overloads by having suitable characteristics so that all loads in excess of the capacity of the charger would be transferred to the battery.
- In the event of failure of A.C. supply, the battery shall meet the complete D.C. requirements. After the discharge of battery to a considerable extent, the boost charger on restoration of A.C. supply shall recharge the battery in a short period. During the period of boost charging, the D.C. load requirements of power station shall also continue to be met.
- The distribution board with necessary switch and interlock, if any, shall be provided for distributing the D.C. power for the control & protection circuits, emergency D.C. supply for essential lighting etc.
- The bidder may give his recommendation on the scheme of operation of battery, battery chargers as described in the specifications. However, the decision of the owner in this regard shall be final and bound to the bidder/contractor.

  The battery shall be capable of delivering the rated output at the minimum temperature of -3°C and maximum temperature of +40°C.
- The battery shall be mounted on the two tier wooden racks supplied along with the battery. Each cell as well as its locations shall be numbered for proper record of maintenance operations. Battery should be placed on the porcelain base kept on the wooden rack.
- The battery shall be connected to D.C. distribution board by single core cables laid above ground. Suitable terminal arrangement with glands shall be provided for this purpose.

- Battery room shall be painted with acid proof paint. Exhaust fans should be provided in the battery room. Contractor shall submit the details of the same to the owner.
- Battery room shall be corrosion proof type lamp and fixtures.
- The ripple content in the D.C. current shall be less than 1%.
- The float charger unit shall be capable of supplying continuous D.C. load and trickle charge the battery.
- Necessary alarm and indication shall be provided with the DC System and also in the annunciation window of the Battery Charger.
- Necessary terminals with lugs for earthing the charger panels with two distinct separate earthing for each panel shall be provided. In addition, separate terminals for earthing of equipment shall be provided. The charger panels shall have space heaters.
- Compression type cable glands of suitable rating for PVC unarmoured cable, suitably mounted in the panel for cable entry from the bottom for A.C. & D.C. supplies shall be provided.
- Type of cell, cell terminal, containers and installation of battery, chargers, inverter, DC Distribution Board, cables etc. should conform to the latest edition of relevant Indian Standard.
- During installation of battery, charging & discharging and charging is to be done proper installation procedure.

5.13.10.4 TECHNICAL REQUIREMENTS

Minimum technical requirements for the DC Battery, Battery charger and DC Distribution Board are as following.

- The battery shall be made of lead-acid cells with tubular type plates conforming to latest issue of IS 1651. The battery cells shall be high discharge performance (HDP) type.
- The capacity of 220 V D.C. batteries based on 10 hours discharge rate shall be selected to fulfill the plant"s requirement. The contractor shall propose the same to the owner and decision of the owner will be final and bound to the contractor.
- The battery shall normally remain under floating condition with the charger supplying the normal continuous load. However, the battery shall be capable of

  supplying the load without fall of terminal voltage per cell below 1.85V (92.5% of rated voltage).

- The number of cells of the 220 volt battery bank at Main Control Room and required voltage at Local Control Room shall be chosen to suit the following conditions.
- Nominal floating voltage per cell shall be between 2.15 and 2.21 V.
- The voltage of each cell under floating conditions shall be of optimum value for its performance and maintenance in a healthy condition.
- The voltage of the battery after meeting the D.C. load cycle shall not be less than 90% of the rated voltage. The manufacturer shall ensure safe operation of the battery after the aforementioned end voltage.
- The voltage across the load shall not exceed 110% of rated value under charging conditions of the battery. To achieve this condition under quick charging, a blocking diode may be incorporated by the supplier in the charging equipment.
- The bidder shall clearly justify the choice of number of cells in the tender on the above lines and furnish any clarifications required by the owner.
- All cell terminals shall have adequate current carrying capacity and shall be of lead-alloy or lead-alloy reinforced with copper core inserts. Cell terminal posts shall be equipped with acid resisting connector bolts and nuts.
- The electrolyte shall be of battery grade sulphuric acid. The battery shall be transported dry.
- The charging equipment shall preferably employ solid state full wave rectifier in a 3 phase full wave bridge circuit with suitable filter circuit of AC ripples, suitable for operation in conjunction with static voltage regulator. A.C. and D.C. Circuit breakers with thermal overload and instantaneous short circuit releases shall be provided on input and output sides of chargers respectively.
- Capacity of the float charger and the boost charger in the float cum boost charger shall be sufficient to meet the system requirement. Contractor shall submit the details to the owner.
- The charger shall be capable of providing the floating voltage between 2.15 V to 2.21 V per cell with the variation of not more than +1% irrespective of input supply voltage fluctuations within +/-10%, frequency fluctuation within +/-5 % throughout its ampere rating with ambient air temperature range of -30C to 400C.
- The DC Distribution Board (DCDB) shall be free standing, self-supporting and floor mounting type. It shall be totally enclosed and compartmentalized. DCDB shall be made as per relevant Indian Standard.
- One equivalent capacity of Incomer provision shall be there to connect with existing DC system with a castle key interlock

- The Emergency Lighting Board supplying the emergency lighting requirement of the power house at A.C shall have an arrangement so that automatic changeover to emergency lighting in case of A.C. failure, is achieved through an inverter of suitable capacity. Normally, the inverter shall run on AC. supply. In the event of failure of AC, the inverter shall automatically switch-over to DC supply and feed the selected emergency loads (lighting loads) at 230 V AC. On restoration of AC supply, the inverters load will automatically return to AC.

The DC system shall have necessary control & protection arrangement which include but not limited to the following.

- Auto/Manual selector switch
- Digital D.C. voltmeter, ammeter
- A.C. failure alarm
- Ground fault relay and its annunciation
- Double pole D.C. contactor of suitable capacity for annunciation
- Triple pole A.C. contactor of suitable capacity for ON/OFF operation
- MCCB and DC contactor of suitable capacity in output circuit of each charger to suit the operation requirements.
- Indicating lamps, as required
- Triple pole, A.C. circuit breaker of sufficient capacity to meet system requirements & capacity with overload and short circuit release for incoming A.C. supply to charger panel
- MCB/MCCBs for A.C. supply to individual chargers
- A.C. under voltage relay
- A.C. voltmeter, ammeter etc.
- Nearest local control room from the main control room should be connected with 220 V DC from Battery Bank DCDB.
- 220 V AC/DC converter is to be provided in each isolated switchgear for operation of circuit breaker/isolator as and where required. Power required in ACDB/DCDB for illumination, control system etc. for each control room should be collected from 415 V (3phase+N) transmission line with necessary cables and protection.

5.13.10.5 APPROVAL

The Detailed Design Report submitted by the contractor to WBPDCL must contain but not limited to the following details of the DC system:

- Detailed specification of all the items.
- Necessary Drawings
- Test Certificates etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Detailed schematic, connection and control wiring diagrams etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCL.

5.13.10.6 SIZING CRITERIA FOR BATTERY

The successful bidder shall determine Battery Duty Cycle curve. The procedure for estimating battery capacities shall be as per guide-lines stipulated in latest revision of IEEE Std. 485 for Lead acid battery and IEEE std. 1106/IS 10918 for lead acid battery. Dererating factor for prolonged float charging shall be duly taken into account, as applicable, in estimating battery capacity. While estimating battery capacities, aging margin as per relevant standard, temperature correction factor as per manufacture's standards and a design margin 25% shall be considered. Important loads to be considered while deciding duty cycle of station batteries are to be tabulated below but not limited to following

1. 33KV Switchgear
2. 415V Switchgear
3. Misc Instrumentation
4. Annunciation system & intercommunication system
5. DC Lighting
6. Any other load (to be decided by successful bidder)

Continuous momentary (0-1), continuous emergency (1-59 min) and impulse (59-60 min) loads shall be calculated and duly considered in battery duty cycle curve. Emergency DC lighting as stated shall be considered for 0-60 minute period for sizing the battery and battery charger of ash handling system.

FITTINGS & ACCESSORIES

BATTERY

Each set of battery shall be equipped with fittings and accessories as listed below	
1.	One battery log book
2.	Two copies of printed instruction sheet.
3.	One no. cell testing voltmeter (3-0-3 volts) complete with leads
4.	One no. rubber syringe type hydrometer suitable for specific gravity reading
5.	Three nos. pocket thermometer.(Digital type)
6.	One no. thermometer (0 to 100deg C) with specific gravity correction scale
7.	One set cell bridging connector
8.	Two nos. each Electrolyte resistant plastic funnels and plastic jugs
9.	Battery racks suitable for accommodating the cells coated with paint
10.	Insulator (with 5% extra), rubber pad etc. for rack
11.	Two nos. plastic filling bottle for filling up
12.	One pair of spanners.
13.	Requisite quantity of electrolyte with 10% extra in non-returnable containers
14.	Two pairs of rubber hand gloves.
15.	Two nos. cell lifting straps.
16.	One set of inter cell, inter tie and inter bank connectors as required for complete installation.
17.	Self adhesive PVC stickers for cell numberings
18.	Goggles.
NOTE:	Any other accessories if required for satisfactory operation of the complete battery system shall also be included in Bidder's offer and to be supplied accordingly.

5.13.11 RELAYS (For HT and LT Switchgear)

I. General- A

a) All relays & timers in the protection circuit shall be flush mounted with connection from inside. They shall have transparent, dust tight covers, removable from the front. They shall have built-in testing facilities. Except small auxiliary relays and timers all relays shall be draw out type.

b) Relays shall be rated for operation on 1A / 5A secondary current and 110V secondary voltage to be decided by the bidder. Number and rating of relay contacts shall suit the job requirements.

c) The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock. Application check shall be made on all protection relay. The result of such check shall be furnished for approval.

d) It shall be the responsibility of the Bidder to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers to provide satisfactory discrimination.

e) All setting devices shall be accessible after removing the front cover. No relay shall be mounted on the rear side of Switchgear panel.

f) All relay coils and their auxiliary contacts (including un-enabled relays in Composite Numerical Relays, if any), including spare contacts will be wired up to the terminal blocks of respective panels for wiring to remote panel / PLC and for future use.

g) Parameterization and loading and downloading of data shall be possible from local HMI as well as from remote panel / PLC.

h) All numerical relays shall have front communication port for parameterization, loading and downloading of data through Laptop.

i) All numerical relays and multi-functional meters shall be hooked up and connected with HMI through Fiber Optic cable.

II. General- B

a) All protective relays shall be of numerical microprocessor based multifunctional type having communication facility.

b) All relays shall conform to the requirements of IS: 3231 / IEC: 60255 standards. The Numerical relays shall have communication, Metering and monitoring facility.

c) Bidder shall ensure availability of spare parts and maintenance support for the equipment for at least 15 years from the date of supply.

d) Separate Master trip Lockout Relay shall be provided for all VCB, SF6, ACB operated HT and LT system.

e) Any foreign relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum 15 years. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation.

III. Technical Requirement

a) **Auxiliary Power Supply**

Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240V with tolerance of ± 20%. The auxiliary power supply shall preferably be site selectable requiring no additional hardware.

b) **Basic Requirement and Constructional Requirement**

i. Relays shall be suitable for flush mounting on the front with connections from the rear. The enclosure shall be dust tight having degree of protection minimum as IP: 52.

ii. Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relay, the terminals shall be easily accessible for testing and commissioning.

iii. Relay shall have self-diagnostic feature with indication of relay failure on relay front. However, while diagnostic circuit runs, it must not interfere in the main protective relay circuit and allow working of main protective circuit continuously. Relay faults (self-diagnostic) shall be communicated and annunciated to HMI.

iv. Design of the relay shall be such that it must operate selectively and with proper discrimination. It must be immune to any kind of electromagnetic interference. Vendor to submit all related type test reports for the offered model along with the offer.

v. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control relay, which shall trip the circuit breaker when relay is de-energized, shall be employed in the circuits.

vi. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Owner.

vii. The internal clock of the system shall be synchronized through the GPS Time Synchronizing System.

c) Display & Indication

i. All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable.

ii. All relays shall have LED / LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65°C for contrast and legibility.

iii. As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.

iv. The relay shall have at least 6 programmable LEDs on relay front.

d) **Software Security**

Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, settings, and status and event data as read only parameters should be without password protection. All software shall be user friendly and latest up to date version.

e) **Disturbance, Event Recording & Data Storage**

Status, disturbance data and events shall be stored in non-volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.

f) **Trip Circuit Supervision & Lock out function**

i. Relay shall have built in lockout function. Lock out feature shall be self reset or hand reset and shall be software selectable.

ii. Relay shall have built in trip circuit supervision function.

g) **Input / Output Interface, Filters and Galvanic Isolation**

h) Relay shall have at least 4 NO contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.

i. Relay shall be made immune to capacitance effect due to long length cables.

ii. All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

i) **Serial Communication**

i. Relay shall have RS485 or FO (Fiber Optic) port for serial communication.

ii. All relays should be able to communicate with remote panel / PLC system. Data shall be available at the remote panel / PLC on request.

iii. Protocol adapted for communication to remote panel / PLC should facilitate easy interface with worldwide used open protocol like Modbus or IEC 103 protocols.

iv. It shall be also possible for Relay Parameterization as well Downloading of Disturbance Records from PC/ Laptop provided in Unit & Engineering Workstations located in Control Room of PWS. Necessary user friendly and latest software to be provided for this purpose. Communication protocol shall be selected from relay to PC to provide all information.

v. One (1) set of Laptop, loaded with common support software and which will allow easy settings of relays in addition to uploading of event, fault, disturbance records and measurement from relay front communication port. The Switchgear supplier shall furnish CD's for the above relay parameterization as well as download of disturbance recorder for all relays of his supplied switchgear. Accessories like table/chair/desk/power socket etc. as required for all PC/Laptop should be supplied.

5.13.12 PROTECTION SYSTEM (HT and LT Switchgear)

5.13.12.1 SCOPE

The scheme shall consist of design, engineering, quality surveillance, manufacture, tests at manufacturer's works before dispatch, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run and commissioning, handing over to the purchaser of protection system for

- PV Array yard
- Solar Inverter
- Three winding Step up Transformer
- Incomer feeder for 33 kV Switchyard
- Outgoing feeder for 33kV Switchyard
- Station Auxiliary Transformer

The protection system shall include protection relays, trip relays, relay contacts, trip & alarm circuits, Annunciation system, diagnostic system, other necessary equipment with all accessories, wiring and cubicles for making the protection system complete for 5 MW Floating Solar PV Power Plant in STPS, West Bengal.

5.13.12.2 STANDARDS

All materials and equipment shall conform to latest edition of relevant Indian/IEC Standards unless otherwise specified. Equipment conforming to any other

authoritative standard ensuring equal or better quality than the standards indicated below will also be acceptable. However, in such eventuality, the salient points of difference between the standards adopted and the standards mentioned below shall be brought out by the bidder. The list of reference standards is given below:

Sl. No.	Standards	Description
1	IS: 2705	Current Transformers
2	IS: 3156	Voltage Transformer s
3	IEC: 60255 (Part 1 to 23)	Electric Relays
4	IEC: 60337	Control switches and low voltage switching devices for control and auxiliary circuits
5	IS: 1885	Electro-technical vocabulary on Electrical relays, Electric Power System Protection and Switchgear & Control
6	IS:13947	Degree of protection provided by enclosures for low voltage switchgear and control gear
7	IS: 3231	Electric relays for Power System protection
8	IS: 5834	Electric Timer relays
9	IS: 8686	Static Protective relays

5.13.12.3 TECHNICAL REQUIREMENTS

The technical requirements of the protection system shall be but not limited to the following.

- Protection shall be designed to ensure reliability, sensitivity and stability under through fault conditions of the system.
- The protection system shall be fully integrated with SCADA system.
- The protection scheme shall be coordinated with control & protection of solar modules, solar inverters and generator transformers etc. All protection, though not specified but which are recommended for this capacity of the machine as per relevant IEC / other Standards shall be provided.
- The protective relays shall be of the numerical, fully tropicalised, plug in type, arranged in protection cubicles including all ancillary devices, such as interposing transformers, tripping matrix and relays, test facilities, power supply units, etc. with all circuits complying to latest editions of IEC 60255-4 recommendation or British Standard 142 and 5992, parts 1, 2 and 3 or relevant Indian Standard. However necessary SAS integration provision shall be there.
- The relays/protection system shall be of state of the art of technology and only latest proven versions of the relay series shall be offered. If the protection system

mentioned in the awarded Contract become obsolete at the time of supply, the Supplier shall offer the latest model with the approval of Employer, without any extra cost.

- Protection system shall be provided to prevent operation of protective equipment due to, magnetizing current inrush during switching-in of the transformer from the high voltage side.
- Precaution shall also be taken so that the unavoidable inductive and capacitive couplings from the power circuits do not cause disturbances.
- Protection relay shall have features but not limited to the following:
    - Man machine communication interface with alarm and trip value setting, displaying of alarm/trip set values, alarmed/tripped values, fault current and disturbance values etc.
    - Self-supervision and indication of any failure.
    - Continuous monitoring of external and internal auxiliary voltages
    - Easiness of replacing a set in case of failure.
    - Communication interfaces or ports.
    - Indication of alarm and trip condition.
    - Test facilities etc.
- All devices shall remain inoperative during external faults and transient phenomenon. They shall be insensitive to mechanical shocks, vibration and external magnetic fields.
- The protection relays, shall be located in conventional panels and shall be flush mounted in dust and moisture proof cases with protection class IP 54 and of the draw out type with rear connections. The protection class of the cover for all relays or protection systems, in which the modules are mounted, shall not be inferior to IP 54.
- The protection systems shall be fed by the battery banks installed in the main control room and local control rooms. Relay shall be suitable for operation on DC systems without the use of voltage dropping resistors.
- The supplier has to supply the equipment for protection of best quality. The supplier has to maintain control and quality assurance during the manufacture, installation, testing and commissioning of equipment as per approved quality assurance plan.
- Minimum protection functions to be provided for different type of circuits are listed below -

For 33kv Incomer feeder-

a) 3 Nos. IDMTL over current (51) for phase fault
b) 1-Definite time O/C relay (50 N/2) for earth fault.
c) Under voltage with time delay (27)
d) VT fuse failure

For Outgoing feeder-

a) 3 Nos. IDMTL over current (51) for phase fault feeder
b) 1-Definite time O/C relay (50 N/2) for earth fault.
c) Under voltage with time delay (27)

For Transformer-

a) 3 Nos. IDMTL over current (50/51) with high set instantaneous units for phase faults
b) 1 No. Definite time O/C (50G) for earth fault (through CBCT)
c) 1-Definite time O/C relay (50 N/2) for earth fault
d) Differential protection (for transformers rated 3MVA and above)
e) Restricted Earth fault (64) for Transformer LV side from transformer neutral including LV side Bus duct / cable.
f) Low vacuum alarm and trip.
g) Winding temperature alarm and trip.
h) Oil temperature alarm and trip.
i) Pressure relief device operated alarm.
j) Conservator oil level low alarm.
k) Double float type Buchholz protection.

LT Incomer:

- 3 Nos. IDMTL over current (51) for phase fault
- 1-Definite time O/C relay (51N) for earth fault.
- Under voltage with time delay (27)

LT 160 kW Motor Feeders :

- Thermal model with negative sequence current.
- - Voltage compensated acceleration.
- - Under voltage, over voltage protection.
- - Overload protection.
- - Short circuit & SC back-up.
- - Current unbalance.
- - Ground fault (through CBCT)
- - Temperate monitoring (stator, bearing etc.).

- - Phase reversal.

Apart from above suitable provision for metering and monitoring such as voltage,

5.13.12.4 APPROVAL

The Detailed Design Report submitted by the contractor to WBPDCL must contain but not limited to the following details of the protection system:

- Detailed specification of all the items.
- All required drawing etc.

Prior to the delivery of the products, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation
- Instruction O&M manual Testing & commissioning manuals
- Detailed BOQ covering protection relays, CTs /PTs, DC Sources and all other devices.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCL.

5.13.13 EARTHING AND LIGHTNING PROTECTION SYSTEM

5.13.13.1 SCOPE

The scope of work under this specification covers the design, supply, transportation, delivery at project site, transit insurance, storage at site, erection, testing & commissioning of electrical grounding and lightning protection system along with necessary materials. All the equipment and building shall be protected from lightning through Lightning Protection System.

5.13.13.2 STANDARDS

The grounding system shall conform to the requirement of following standards.

Sl. No.	Standards	Description
1	ANSI/IEEE: 80 –2000	Guide for safety in AC Substation Grounding
2	CBIP Publication: 223	Design of Earthing Mat for High Voltage substation
3	IS: 3043	Code of Practice for Earthing Indian Electricity Rules

5.13.13.3 OBJECTIVE

The grounding system shall be designed with the following objectives:

- To provide low impedance path to fault currents, during ground faults, to ensure prompt and consistent operation of protective devices to effect isolation
- To keep the maximum voltage gradient during ground faults along the surface inside and around the switchyard, PV array yard, control rooms etc. within safe limits
- To protect the life and property from electrical shocks due to over voltage
- To stabilize circuit potentials with respect to ground and limit the overall potential rise

5.13.13.4 TECHNICAL REQUIREMENTS

Minimum technical requirement of the earthing system is mentioned below.

- The earth resistance should be less than 1 Ω.
- Suitable number of earthing pit shall be provided at the array field.
- Design and installation of the earth mat and other associated system shall confirm IS: 3043 and shall be followed by modern practice.
- The earthing for solar field and power distribution system shall be made with GI pipe of suitable size including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043. The Mounting structure shall be grounded properly using GI strips and maintenance free earthing kit.
- Size of ground earth mat shall be 1000mm below FGL and 40 mm dia MS rod
- Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.
- The earth conduction shall run through GI pipe partly buried and partly on the surface of the control room building.
- The complete earthing system shall be mechanically & electrically connected to provide independent return to earth.
- All three phase equipment shall have two distinct earth connections.
- Along the cable trays suitable size of GI Flat shall be provided inside the control room.
- For each earth pit, necessary Test Point shall have to be provided.
- The earthing system shall be connected to the following.
    - Solar modules with suitable number of earthing pit at the solar array field
    - The neutral point of each system/equipment

- Equipment framework and other non-current carrying parts
- Frames of panels & cubicles
- Metallic structures of switchgear, cable racks, casing of cable boxes
- Equipment supporting Steel structures
- All extraneous metallic frame work not associated with equipment
- The earth point of lightning arrestors; voltage transformers and lightning conductors through their permanent independent earth electrodes.
- Fence

- For equipment connection to mat/riser, 50 mm x 6 mm or higher size GS flat shall be used.
- Each neutral point of transformer shall be provided with two separate treated earth pit through 80 mm dia GS perforated pipe having 3 mtr depth. Necessary charcoal, salt etc. to be provided for earth pit as per relevant standard. Each earth pit shall be connected with Main earth grid through a bolted type test point.
- Separate grounding grid to be provided for electronic earthing for PLC system.
- The conductor shall be of adequate cross-section to safely withstand the system fault current for time duration of fault clearance by the remotest/back up protective system.
- Sufficient allowance needs to be provided for corrosion of the embedded conductor on account of chemical properties of soil and also due to galvanic action with other embedded systems.
- For determination of the size of the conductor, the value of fault current may be taken as 40 kA; duration of fault current may be considered as 1 second. The extra allowance of 20% to take care of corrosion shall be added to arrive at final conductor size.
- For designing of the earth mat for 33kV switchyard, the material of ground mat conductor shall be 40 mm MS rod and that of risers emanating from ground mat shall be GS flats. Soil resistance of the site is available in the soil report.

Lightning Protection System:

Lightning protection work shall be carried out in compliance to the following standards/codes. All standards, specifications and codes of practice (COP) referred to herein shall be the latest editions including all amendments and revisions as on the date of opening of bid. In case of conflict between the

specification and those standards/codes referred to herein, the former shall prevail:

- Indian Electricity rules
- National Electrical Code
- COP for the protection of building and allied structures against lightning : IS 2309
- Recommended practice for hot-dip galvanizing of iron and steel: IS 2629
- Method of testing uniformity of coating on zinc coated articles : IS 2633
- Methods for determination of mass of zinc coating on zinc coated iron and steel articles : IS 6745
- IEEE guide for instrumentation and control equipment grounding in generating stations : IEEE 1050;
- Lightning protection will also be provided for building/ structures where the overall rise factor exceeds 10^{-6} as per IS: 2309

5.13.13.5 APPROVAL

The successful bidder shall carry out the earth resistance measurement at the site and they need to submit the measurement report to WBPDCL.

The Detailed Design Report submitted by the contractor to WBPDCL must contain but not limited to the following details of the earthing system:

- Detailed specification of all the items.
- Soil resistivity measurement data
- Necessary calculations and drawings etc.

The successful bidder required to produce schematic diagram of the earthing system and the proposed locations for earth mat as per relevant standard with the Detailed Design Report.

All drawings and calculations submitted by the contractor will be subjected to approval of the WBPDCL.

5.13.14 CONTROL, MONITORING AND DATA ACUSITION

5.13.14.1 SCOPE

The scope of work under this specification covers the design, engineering, manufacture, testing at manufacturer's works, transportation, transit insurance, delivery at project site, storage at site, erection, testing at site and commissioning of Control, monitoring & Data Acquisition system comprising of computers, VDU, key board/mouse, SCADA System, PLC's, input and output relays, meters, fields sensors, panels/cubicles for housing above equipment/devices, power supplies, transducers, converters, wiring etc to make the system complete.

5.13.14.2 REQUIREMENT

- The automatic control panels shall be located in each control room. The control panels shall be provided with local automatic selection. On local automatic selection, control will be transferred to control panels located in local control rooms from where unit can be started by single push button control.

- SCADA system with all hardware & software for integrated operation of total Solar PV Plant is to be provided.

- SCADA system shall have data logging and display system for continuous monitoring of data.

- In addition to the real time trend, SCADA shall also have provision for offline viewing and retrieving of historical data of all parameters. All the trend and cumulative graphs shall be able to view and store. Also all the events including outages and faults shall be logged and stored with time and date stamped. SCADA should also have provision for offline viewing of daily, monthly and annual average of all the parameters.

- Bidder shall provide 2 (two) nos. Engineering cum Operators' Work Station cum Historian.
  Bidder shall also supply a network printer.

- HMI peripherals shall be kept inside main control room. Total solar PV plant shall be controlled from there.

- SCADA PLC System shall have hot redundant processor, redundant communication controller and redundant power supply modules in each rack.
  Processor shall not be loaded over 60% of the individual capacity even under worst data loading conditions.
  SCADA Communication Network shall have redundancy at all level.
  Internal Bus and external data network loading shall in no case be more than 60% of its capacity.
  SCADA system shall be OPC compliant.

- The SCADA shall have the feature to be integrated with the Network system as well as remotely via the web using either a standard modem or a GSM/WIFI modem. The contractor shall provide compatible software and hardware so that data can be transmitted via standard modem.

- The SCADA work station and push button control panel shall be interlocked by means of hardwired and software (Logic) to ensure smooth and safe operation of the plant.

- All pre-synchronisation checks shall be made to ensure normal and safe operation of the machine. Detailed philosophy shall be submitted by the contractor.

- System shall acquire on continuous basis the parameters of PV array, like DC current of string, DC voltage of each combiner box etc., Parameters of Solar Inverter like Power at the input of each inverter, Power at the input of each inverter, phase current, voltage, PF, MVAR, MW, Frequency etc., similar parameters of Generator Step-up and auxiliary Transformers etc.

- The Monitoring system shall perform String level monitoring for trouble free operation and maintenance of the plant. System shall indicate these on VDU Mimic alongside relevant device.

- System shall monitor and indicate on VDU status of all electrical devices including all switchgear.

- System shall provide mimics of main single line diagram, Auxiliary SLD and DC SLD in colour. The parameters as above shall be displayed by the side of respective device in proper units of measurement.

- The control & monitoring system for the generating units shall be microprocessor based digital control.

- The data logger shall have reliable battery backup and data storage capacity to record all sorts of data simultaneously round the clock.

- Inverters should be integrated with SCADA and provision of Data logging should be there. Logger should have the provision of recording the data of solar

insolation, PV Module temperature and ambient temperature and associated electrical parameters at different stages to study performance of system as well as to study status of the system at a particular instant. The data logger should have required transducer to monitor and record the required system data. The data logger should be provided with an insolation sensor and a module temperature sensor, ambient temperature sensor matched with the system.

- Plant based Remote Monitoring system must be compatible with data logger. The other required accessories, hardware and compatible software shall have to be provided as an integrated part of the system to monitor the real time data through the server. The Data logger shall continuously send data to the server.
  Plant based Data logging system may be provided with special software (minimum 10 users). Upgradation of the software, if any, shall be done by the contractor. The server shall not be provided by WBPDCL or end-user.

- In case the data cable to be laid in the array field, SPD (surge protection device) suitable for communication network, as much number at suitable location are required must be provided with the system.

- The Plant based monitoring system should have the provision of graphical representation of the data shall include but not limited to the following:

SI. No.	Operating Parameter	Desired specification
1	Input data	PV Power PV Energy
2	Meteorological data	Insolation (inclined on the plane of module as well as horizontal) Module Temperature Ambient Temperature Wind Velocity
3	Output data	Inverter Export Power Inverter Export energy

- All data shall be recorded chronologically date wise. The data file should be MS Excel/XML/any readable form compatible and should have the facility of easy downloads.

- IT grade server may be installed including provision for back up data at least for 02 years.

- Screened instrumentation cable, Cat6 cable and fibre optic cable and other hardware as required for interconnection and complete commissioning of SCADA system and complete commissioning of solar PV power plant shall be supplied by the bidder.

- **Power Supply System:**

  - Bidder shall supply 2X100% parallel redundant Uninterruptible Power Supply (UPS) system (along with 2x100% Ni-Cd battery bank).

  - UPS system shall have Battery bank (Nickel Cadmium type) for at least 1 hour back-up.

  - Power supply distribution to all the consuming points shall be in the scope of Bidder. The exact power supply scheme shall be submitted by Bidder during detailed engineering stage for Owner's approval.

  - PLC system as well as all system peripherals such as operator work stations (OWS), engineering stations, servers, printers etc., CCTV system, Fire alarm panel etc. shall be powered from UPS system.

  - Any other system that requires UPS power, as per OEM requirement, shall be powered from UPS system.

- **Air conditioned main control room:** Main control room shall have humidity controlled Air Conditioned environment.
  Following items shall be installed in A.C. environment inside main control room -
  SCADA system along with PLC panels, HMI peripherals, UPS system, CCTV server along with LED display, Fire alarm panel etc..

- **CCTV system:** Bidder shall supply IP based Close Circuit Television (CCTV) System for the plant and control room building surveillance.

PTZ (Pan-Tilt-Zoom)/CCTV outdoor/indoor cameras covering the whole plant (nos. of cameras requirement shall be as per design for well coverage of the plant) and total Inverter cum Control Room to be deployed with night vision and central monitoring through 42" LED monitor/TV at control room.

Plant monitoring through CCTV system shall be done from the main control room. So, the CCTV system shall be placed inside main control room.

CCTV system shall be powered from UPS ACDB.

Bidder's scope of supply shall be CCTV system comprising CCTV cameras, Management Server, Recording Server, Network Storage Device, L2 Ethernet Switch, OFC, Cat 6 cable, power cables, cable protections, cable conduits & sub-trays, supports, junction boxes, distribution frames, enclosures etc. and grounding connections as required for safe and trouble free operation of IP Based CCTV SYSTEM

- Bidder shall supply proven latest version of hardware and software available at the time of system designing. All software (supplied for the project by the bidder) user licenses shall be valid for entire life of power plant. User should not have to pay any recurring license fee during the usage period of the system. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system at per with the new version within the warranty period and ensure successful integration of the system without any additional cost to owner. Beyond the warranty period and during the remaining life of the plant, any up-gradation in hardware and software shall be brought to the notice of Owner indicating whether it shall be possible to upgrade the system by partially replacing, modifying and/or patching of hardware /software.

- Also user license for all the software shall not be machine specific. That is, if any hardware / machine is upgraded or changed, the same license shall hold good and shall not be necessary for owner to seek a new license/renew license due to upgradation/change of hardware/machine in system at site.

- Password security shall be provided in order to ensure security level to the plant operation.

5.13.14.3 TECHNICAL SPECIFICATIONS

(A) PROGRAMMABLE LOGIC CONTROLLER (PLC)

1) Programmable Logic Controller (PLC) shall meet the following general requirement:

i) Each PLC shall have redundant Central Processing units (CPUs) of word length of 32 bits minimum.

ii) Each CPU rack shall have redundant Power supply units, CPU, IO communication processor (between IO Rack & CPU), Communication processor (between CPU & HMI via ethernet switch), memory module (if applicable etc.

iii) Each IO rack shall have redundant Power supply units, IO communication processor (between CPU & IO rack) and IO modules.

iv) The redundant CPU rack and IO rack shall be connected through redundant data highway.

v) The CPU rack shall be connected to the operator station through redundant 10/100 Mbps data network.

vi) IO racks shall be backplane type. i.e, the IO cards mounted on the rack shall be on the back plane

Two CPUs shall operate on fault tolerant mode with continuous self and cross-monitoring facility. Failure of the active CPU shall not affect the operation of the plant.

In the event of failure of active CPU, tasks shall be transferred to the standby CPU bumplessly within fastest possible transfer time without causing any output to drop during the transfer period. The bumpless change over shall be accomplished within one Scan-cycle.Transfer speed shall not be less than 1 Gbit/sec. CPU Redundancy shall be achieved through dedicated hardwared Synchronised Link between active and standby CPU.

In the event of both the CPU failure, the system shall revert to the fail-safe mode. CPUs shall not be loaded over 60% of the individual capacity even under worst data loading conditions. It shall be possible to make a manual transfer from the active to the back-up CPU from engineering station and as well as from the front panel of CPU module. Module shall have adequate status and diagnostic indication on the front panel and as well as on the engineering station.

2) The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% or minimum one number, whichever is higher, spare channel as hot-on-rail spares in each configured cards/modules. In addition to this 10% or minimum one number, whichever is higher, extra assigned complete spare modules mounted on rails in racks for each type of I/O modules shall also be provided. The spare channel and cards shall be fully wired and terminated. Each IO rack shall have 10% spare rack space for IO module installation in future.

3) The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient for complete system operation and shall have the capability for future expansion at least to the tune of 25%. The application program/sequence logic etc. shall be stored in nonvolatile memory (EEPROM). However, all the dynamic memories shall be provided with battery back up at least for 360 hours. The batteries shall be lithium or Ni-Cd type.

4) The number of input / output points per card shall not exceed 32 (Thirty Two) for digital and 16 (Sixteen) for analog/ thermocouple/ RTD. Individual input channels shall have galvanic/optical isolation. Output points shall also have optical/galvanic isolation. Merely fusing of individual or a group of channels is not acceptable.

5) The data communication system of the PLC shall not be limited to the following:

   a) Internal Bus and External data network loading shall in no case be more than 60% of its capacity.

   b) Redundant communication controller shall be provided for the purpose of communication between the I/O modules (including remote I/Os if any) and the PLC as well as in between PLC and the operators work stations.

c) The communication system design shall ensure that any single point failure on the system bus/media shall not disrupt more than single message and disrupted message shall be automatically retransmitted.

d) Failure or physical removal of any station/modules connected on the system bus shall not lead to any loss of communication.

e) Diagnostics message shall be issued on fault detection.

f) Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.

g) Noise immunized and reliable high speed dual fault tolerant optical fibre communication cable between CPUs and remotely located remote I/O modules with standard communication protocol shall be provided.

h) Main data network shall be noise immune high-speed communication link with bit rate in the range of 10 / 100 MB/sec and shall comply with the International Standard IEEE-802.3 (Ethernet) for data exchange and communication.

6) The PLC system shall be open protocol at both layers (OPC compliant) i.e. Supervisory layer (between PLC & HMI) and Control Layer (between PLC & I/O). Supervisory level Ethernet must be unmodified with non-proprietary application layer.

All PLC based controls shall have provision for interface with main plant DCS for future. Communication for selected data transfer with DCS shall be through OPC soft link.

7) Bidder shall provide 2 (two) nos. Engineering cum Operators' Work Station cum Historian.

One (1) no. A4 colour laser network printer to be provided.

8) HMI function of PC based operator's station shall not be limited to the following:

a) Selection of auto/Manual, open/close operation, sequence auto, start/stop operation etc.
b) Dynamic Mimic display depicting the entire process for control and monitoring purpose.
c) Alarm monitoring, report generation, logs, calculations and printing of logs, reports, trends etc.
d) On-line / historical trending, historical storage and retrieval of data.

9) Annunciation System

a) For PLC controlled area / plant, window based annunciation wherever required shall be an integral part of the PLC system. Sequence for annunciation shall be configured in PLC and shall conform to ISA sequence. Window lamps will be driven by PLC. For the systems where only monitor & keyboard based operator workstation has been envisaged, alarm/ annunciation will be displayed in the operator workstation.

b) The window lamps for the system shall be driven through output modules of the PLC. Each window shall have removable lamp box.

The window shall have black lettering inscription on white background.

However, for trip application red background shall be provided. Each of the annunciation windows shall be backlighted with minimum two groups of clustered LED lamps with minimum readable distance of 3 Meter. The window design shall be such that the lamp replacement can be done easily from the front.

c) Immaterial of whether the annunciation is window based or HMI based, one no. Electronic hooter with adjustable sound level and intensity controls to be provided as audible device for the annunciation system.

10) Software

a) All the necessary software for fulfilling the complete implementation of the control logics, operational displays & logs, data storage, retrieval and other functional requirements as indicated in this specification, shall be provided.

b) Offered PLC system must use Tag based addressing structure. Tags must be inherent in the controller not in the HMI. The HMI shall support directly by referring the Tags resident in the controller.

c) Licensed version of required software including operating system, configuration and HMI software shall be provided.

d) Programming language shall be user friendly. Detail documentation on the all programming softwares shall be furnished by Bidder and this shall be a part of the O&M Manual.

e) Contractor shall provide software locks and passwords to Owner's engineers at site for all operating and application software so that Owner's engineers can take back up of these software and are able to do modifications at site.

11) Control & Power Supply Scheme

Bidder shall provide two nos. redundant 240V AC ± 1% UPS (Uninterruptible Power Supply) Power feeders for the PLC system from the unit UPS systems.

All required hardware/ equipment etc. for conversion and/or stabilization of the power source to all other levels which may be necessary for meeting individual requirements of equipment/ systems shall be furnished by the bidder.

Separately mounted I/O racks, shall be provided with separate power supplies. Power supply module shall be of ample capacity to feed all the modules. In addition 20% spare capacity for future shall be provided.

All the drives shall be switched ON/OFF through 24 V DC interposing relays to be located in HT/LT SWGR panels.

Power supply distribution to all the consuming points shall be in the scope of Bidder. The exact power supply scheme shall be submitted by Bidder during detailed engineering stage for Owner's approval.

12) Bulk power supply units for interrogation, relay and solenoid voltage shall be separate from system power supply units and shall be redundant in all cases.

13) The system shall have high MTBF and shall be hot maintainable. The system hardware shall be designed to be `fault avoidant' by selecting high-grade components of proven quality and properly thermally de-rated design. The network shall have extensive fault monitoring, self-surveillance & on-line self diagnostic capability so that failure up to module/card level is immediately detected. Each of the modules shall have its self-diagnostic system. The operator workstation located at the local area control room shall be used for fault data presentation and monitoring purpose.

14) It is preferred that Termination & Relay cabinet shall be separate from the system and RIO cabinets.

15) Data exchange in a bus shall be fully monitored and checked for validity.

16) Response time consisting of IO scan time, Data communication time, Processing time etc. shall be equal to or less than the following:
    a) OLCS & sequence control inputs : 100 ms.
    b) CLCS inputs : 250 ms.
    c) Monitoring analog parameters : 500 ms.
    d) Monitoring digital parameters : 100 ms.

17) Following operations will be performed on I/Os, as required:
    a) Square root extraction
    b) Pressure & temperature compensation
    c) Reasonability check of all inputs (analog specially), validate and quality tagging like good, bad, suspect etc.
    d) Channel wise engineering unit conversion
    e) Contact bounce filtering with adjustable time constant.

18) All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose.

    Adequate software capability shall be provided to implement closed loop control functions as follows:
    a) PID control and their variations.

b) On-off control

c) Cascade control

d) Ratio and bias control

19) Features for Open Loop Control shall not be limited to following:

a) Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono-shots etc.

b) The automatic sequence control to ensure sequential start up and shutdown of auxiliaries/equipment. Sequence control shall be performed in groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for `waiting time' and `monitoring time', and it shall output an action on the process. System shall have the capability to bypass a step if desired by the operating personnel from the operator workstation. Such action however shall be registered as an exception or alarm.

c) Increase the reliability and availability of the plant as a whole, for example, by timely and correctly switchover to standby drives etc.

d) Priority of the following commands shall be as follows:

i) Manual intervention shall be possible at any stage of operation.
Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

ii) A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program.".

20) Interface of the system with MCC/Switchgears shall be in the form of potential free contacts via interposing relay modules mounted in the respective MCC/Switchgear unit. All other interposing relays (like solenoid valve etc.) shall be mounted in a cabinet seperate from the system cabinet.. 10% wired additional interposing relay modules shall be provided as installed spare.

Freewheeling diodes shall be provided across the coil of DC solenoid and contactors/relays. For AC solenoids and contactors directly driven from output cards, arc suppressors shall be provided across the coil.

Each RIO rack shall have 10% spare rack space for future up gradation.

21) The operator's station shall be responsible for handling all commands as well as in generating desired displays and print outs.

22) Programming shall be with an easily understandable high-level language. Programming shall also be permissible by drawing Ladder or Boolean Diagram. Single programming instruction/command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the program. The active and the stand-by CPU programs shall equalize automatically, once the new program is permitted to 'RUN'.

23) Updating time and reaction time under worst case loading condition (system's response to an operator's command) for operator stations shall be as follows:
   a) Calling up a mimic : 2 sec or better
   b) Updating status signal in mimic : 1 sec or better
   c) Updating variables in a mimic : 1 sec. or better
   d) Issuance of command to output : 1 sec. or better (without considering process lag)

24) Programmable Controller shall be responsible for real time process parameter monitoring, storage & display.
   Basic requirements are
   i) Operator Interface,
   ii) Basic Calculation,
   iii) Alarm Monitoring with display & audio & Reporting,
   iv) Display generation,
   v) Logs,
   vi) Trend Recording &
   vii) Historical Storage & Retrieval.

25) The displays at the operator console shall be classified into overview display, group display, point display and trend display.

a) Overview display - This display is to enable the operator to set an overview of the entire plant section.

b) Group display - The group display page shall display several subsections & present status information.

c) Point display - Along with the specified parameter value, this page should indicate historical trend of the parameter.

d) Trend display - This display include real time/historical trend display facility including Dynamic Graphic Display & Bar Graph Display.

e) Alarm Message Display - It shall be possible to display process as well as system alarms for operator's attention and action. Alarm shall appear immediately on the operator workstation as and when they occur on priority basis. In addition to alarms appearing on different displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc. Alarm shall disappear from display only when they are acknowledged and cleared.

Abnormal condition in the system shall be displayed as system alarm message on the operator workstation irrespective of display selected.
In all cases occurrence of an alarm shall be logged.

26) Logs shall not be limited to the followings. The printing of these logs shall be initiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

a) Shift/Daily Log
A shift/daily log shall be provided to furnish data for routine analysis of plant performance. This log shall be automatically printed at specified time each day and on demand at any time.

b) Summary Log (On Demand)

The system shall permit the operator to specify minimum of 5 summary logs each with minimum of 25 points to be printed on demand.

27) The salient hardware/ software features of the PLC system for I/O handling shall be as follows.

a) Input filters to attenuate noise.
b) SWC of 500V DC common mode and 500V AC peak to peak
c) Common Mode Noise rejection for analog inputs of 120 db at 50 Hz.
d) Normal Mode noise rejection for analog inputs of 60 db at 50 Hz.
e) LED indicators on each card to show status of individual signal.
f) All the outputs shall be with individual fuse.
g) K type thermocouple mV input where applicable.
h) Pt-100 three / four wire resistance thermometer input where applicable.
i) Non change over/change over type of contacts
j) 24 V DC power supply to field mounted two wires transmitters.
k) 4-20 mA Input
l) 4-20 mA output
m) 24/48 V DC output signals for energizing interfacing relays

28) The salient hardware/ software features of the CPUs as follows:

a) CPU Type : Single slot CPU module
b) Max. scan time for I/O : I/O scan time must be less than 50% of the processor scan time.
c) Maximum Scan Rate : 0.25 ms (Per K Word) or better
d) Memory capacity : 25% spare capacity after full utilization. Expandable in multiples of 16 K.
e) Communication processor : Integral / Separate
f) Battery back up for RAM : Ni-Cd / lithium type, at least for 360 hrs continuous operations during power failure.
g) Watch dog timer : Periodical reset. Alarm and interruption, if not reset within stipulated time.
h) Diagnostic feature : Periodic, automatic self-diagnostic. Result available at the operator workstation.
i) Communications : LAN-supporting multidrop.

29) The salient features of the Input / Output modules are as follows.

a) All modules

1. Ambient temp. : 0-50O C
2. Surge withstand capability : IEC-255.4

b) Digital General

1. No. of channels / module : 32
2. Interrogation voltage : 24V DC or 48 V DC
3. Status indicator : LED type.
4. Isolation : Optical

c) Digital Input Module

1. Contact bounce filtering : Adjustable time constant of 15 m. sec.
2. Diagnostic : Module fault

d) Digital Output Module

1. Output protection : Short ckt. Proof & Individual fuse
2. Diagnostic : Module fault
3. Rating : To switch ON/OFF interposing relays of approx. 3 VA at 24 VDC.

e) Analog General

1. No. of channels / module : 16
2. Isolation : Galvanic/Optical

f) High level Analog Input Module

1. Type of input : 4-20 mA DC / 1-5V DC
2. A/D Converter : 11 bits + Sign (or better)
3. Accuracy : 0.1% or better
4. Diagnostic : Module fault

5 Powering of transmitter : 24 V DC 2 Wire type

g) Low Level Analog Input Module

1. Type of input : Pt-100; T/C(As required)
2. C-J-C : On Module
3. Accuracy : 0.1% or better
4. A/D converter : 15 bits + Sign (or better)
5. Diagnostic : Module fault

h) Analog Output Module

1. Type of output : 4-20 mA DC
2. Accuracy : + 0.1% or better
4. A/D Converter : 11 bits + Sign (or better)
5. Load : 500 Ohm
6. Diagnostic : Module fault

Note : Electrical isolation of 1.5 KV with optical couplers between the plant input/output and controller shall be provided on the I/O cards.

(B) HMI PERIPHERALS :

Sl. No.	Description		Minimum requirement
Engineering cum Operator's Work Station cum Historian			
i.	Processor	:	Latest, minimum Intel Core i5 quad core
ii.	Configuration	:	Tower
iii.	Internal clock	:	3.2 GHz (min.)
iv.	Architecture	:	32 bit
v.	Video Card	:	PCI
vi.	RAM	:	4 GB (Minimum) DDR
vii.	Hard drive	:	1TB SATA (7200 RPM)
viii.	Cache	:	512 KB Level 2
ix.	CD/DVD Drive	:	DVD-Both Read & Write for OWS. Both DVD Read & Write for EWS
x.	Audio controller	:	16-bit
xi.	Operating system	:	windows 8.1 Professional downgraded to Windows 7 Professional 64 bit or latest at the time of detailed Engineering/procurement
xii.	Graphic accelerator	:	8MB (min.)
xiii.	Communication ports	:	(a) RJ-45 NIC- 02 Nos. (b) USB ports – 04 nos. (min.) (c) USB 3.0 - 02 nos.
xiv.	Accessories	:	USB Keyboard, USB Mouse
Monitor for Work Stations			
i.	Type	:	LED
ii.	Screen diagonal	:	24"
iii.	Display	:	Full HD
iv.	Resolution	:	1920 X 1080 or better

Sl. No.	Description		Minimum requirement
v.	Degree of protection	:	IP-30
vi.	External Controls	:	Brightness, contrast, Horizontal / Vertical amplification & shift
vii.	Power supply	:	240 V, 50 Hz, 1 phase
viii.	Ambient temperature	:	0-50 deg C
ix.	Humidity	:	95% non-condensing
x.	Version	:	To suit industrial application (latest version as per availability at the time of detailed Engineering/ procurement
Color Laser Printer			
i.	Type	:	Electro-photographic laser, tabletop
ii.	Printer Memory	:	512 MB (min.)
iii.	Speed	:	Monochrome 24 ppm - A4, Color 6 ppm - A4
iv.	Resolution	:	1200 x 1200 DPI in color
v.	No. of color (Basic)	:	4 (four) minimum
vi.	Duty cycle	:	Monochrome 75000 pages / month
vii.	Power supply	:	240V AC, 50 Hz, 1 phase UPS
viii.	Ambient temperature	:	0-50°C
ix.	Humidity	:	95% non-condensing.
x.	Interface	:	USB and Ethernet (RJ45)
xi.	Size of paper	:	A4
xii.	Print media	:	Plain paper, transparencies, thick stock, glossy stock, envelopes
xiii.	Special Features	:	1) Automatic Two-sided printing. 2) Built in Networking with Fast Ethernet 10/100 Base-T network port.
xiv.	Accessories	:	Connector & Cable

(C) CCTV SURVEILLANCE SYSTEM :

Scope of Supply:

i) CCTV Management Server with mouse, keyboard, and other accessories with all accessories.

ii) Network Storage Device for storing CCTV Camera signals

iii) CCTV Viewing Station with keyboard, monitor, mouse and other accessories.

iv) IP Indoor Dome type IR Varicap CCTV Camera with accessories

v) IP Outdoor Dome/Pendent type IR PTZ CCTV Camera with accessories

vi) Digital Video Management Surveillance Application, Administration and Diagnostic Software

vii) Ethernet Switch with all accessories

viii) All types of cables – 4 Pair (UTP) CAT 6 cable, 6 core single armoured OFC cable etc., 3 Core, 2.5 Sq mm Power Supply Cables etc.

ix) Multi strand Copper wire with green PVC sleeves for grounding of CCTV Controller and other equipment as per tender requirement.

x) All types of Cable connectors for the above Cables – as required.

xi) RJ45 termination box with single faceplate, modular jack, patch panel, patch cord etc.

xii) Power Distribution Assembly and other accessories for extending the UPS power point to equipment – as required.

xiii) Mounting and Installation Accessories - as required.

xiv) Any item, not mentioned above, but required for successful completion of the system, shall be in the scope of the Bidder.

Technical Description for CCTV System:

1. Design Basis

a) The CCTV system shall be IP based based on client server architecture. The CCTV cameras shall be used for plant surveillance and strategic locations. CCTV control equipment shall be located at the control room.

b) IP based CCTV Management Server shall be located at control Room and interfaced with L2 Ethernet Switches. Monitors shall be located in main control room.

c) IP based indoor cameras Fixed Dome type with varifocal lens and IP based outdoor cameras Pendent PTZ type shall be installed. The connectivity between Management server and cameras shall be through L2 Distribution switches of CCTV LAN system with dedicated UTP CAT 6 link between the switch and camera at various locations.

d) The CCTV architecture shall be of distributed type. AC power from UPS shall be extended to all CCTV cameras, Ethernet switches by the Contractor and all power distribution boards with MCB and protection device shall be provided by the Bidder.

e) The main node at control room shall consist of Management Server, L2 Ethernet switch, the storage device, workstation.

The indoor CCTV cameras shall be connected to nearest Ethernet switch over CAT-6 cable. The distribution switches will be connected through Fiber Optic converter over 6 core Single Mode OFC armoured cable to the Main L2 Switch in control room in a combination of ring and star configuration .The Distribution Switches in the nodes shall be connected by Single Mode OFC dual ring configuration so that redundancy is achieved. The routing sequence shall be decided during the time of detail engineering and subject to Owner's acceptance and approval.

f) The new CCTV System and its system elements shall have ONVIF protocol for future provision of interfacing with ONVIF compatible CCTV System.

g) Dome type fixed varifocal lens cameras shall be deployed inside the room whereas Dome/Pendent type PTZ type cameras shall be installed in the outdoor.

2. Central Equipment

a) The Recording server shall be able to store recording of 15 days at 4CIF 25fps at D1 resolution. The system shall have the provision of continuous recording as well as event based recording. The CCTV recording after 15 days shall be

automatically transferred to the high capacity network access storage device. Facilities shall be provided to allow continuous recording of images when in playback mode. Control and set-up of the Video Recording Device shall be possible from the operator keyboards via serial data link.

b) Facilities shall be provided for archiving stored images to Network Storage Device. There shall be a Control System with Video Control Software to manage all the video surveillance devices.

3. Specific Requirement

a) CCTV Systems

i) This section comprises of the detail specification of the equipment like Camera, PC based operating station, SAN/NAS, network switch, media converter, fiber termination box (LIU), optical fiber cable, UTP CAT-6 cable, network rack and other accessories.

ii) Indoor IP Dome type Varifocal camera and Outdoor IP Dome/Pendent type PTZ camera shall be used for image capture.

iii) System must provide built-in facility of Digital certificate or similar type to ensure tamperproof recording so that these can be used as evidence at a later date, if so desired. The recording shall support audit trail feature.

iv) All camera recordings shall have camera ID & location / area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

v) All the cameras shall have the capability of streaming video at 1080p 25fps resolution

vi) Facility of camera recording in real-time mode (30 FPS) at D1 resolution.

vii) System to have facility of 20% additional camera installation beyond the originally planned capacity.

viii) In order to optimize the memory, while recording, video shall be compressed using H.264 or better standard and streamed over the IP network. Once on the network, video can be viewed on a control room and shall be recorded on Recording Server and shall be backed up on archive /RAID Backup device.

ix) The Recording server shall be able to store recording of 15 days. The system shall have the provision of continuous recording as well as event based recording.

x) System shall have provision of WAN connectivity for remote monitoring later date.

xi) There shall be a Control System with Video Control Software to manage all the video surveillance devices.

xii) CCTV Management Server shall keep track of all configurations & events. This will help in proper System administration & management of redundancies etc.

b) IP IR Dome Camera

i) The colour low light sensitive cameras shall be designed for indoor application. The camera shall have high resolution with CMOS sensors including lens, shutter, IR filter (as required).

ii) The camera unit shall have latest compression standard (i.e. H.264 or better), 30 FPS transmission speed, flash/SDRAM memory, LAN port and shall be capable of working on open architecture of Internet Protocol (IP). All the cameras shall have features like automatic gain control, automatic iris control, white balance, auto backlight compensation, gamma correction etc.

iii) Facility of camera recording in real time mode (30 FPS) as well as in any desired combination must be available in the system. Facility of camera recording shall be possible in CIF, 2CIF, 4CIF, as well as in any combination. The video shall be compressed using H.264 standard or better.

iv) The camera enclosure shall include the following:

- Vandal resistant
- Vandal resistant casing with a minimum of IK8 rating
- Fitted with a dehumidifying membrane

v) The camera shall support manually and automatic defined values for:

- Color level
- Brightness
- Sharpness
- Contrast

vi) The camera shall incorporate a function for optimization of low light behavior.

vii) The camera shall provide simultaneous Motion JPEG and H.264 video streams.

viii) The H.264 implementation shall include both unicast and multicast functionality and support Constant Bit Rate (CBR) as well as Variable Bit Rate (VBR).

ix) The camera shall have the provision to be equipped with a RJ45 10BASE-T/100BASE-TX PoE Ethernet port.

x) The camera shall be equipped with a video buffer for saving pre- and post-alarm images and shall have a micro SD-card slot to support local storage of video.

xi) The camera shall support SD/SDHC/SDXC, memory up to 32 GB, speed class 10.

xii) The camera shall support recording to network attached storage.

xiii) The camera shall support both static IP addresses and addresses from a DHCP-server.

xiv) The camera shall support IEEE 802.1X authentication.

xv) The camera shall support IP address filtering and include at least three different levels of password security.

xvi) The fixed camera shall accept Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 2.

xvii) The camera shall be backed by a minimum of three year manufacturer warranty.

xviii) The camera shall meet the following standards:

- IEEE 802.3af/802.3at
- IEEE 802.1X
- IPv4
- IPv6

c) Data Sheet of Indoor Dome type

01. Video Standard	:	PAL
02. Image Sensor	:	Progressive scan CMOS 1/3”
03. Effective Pixels	:	3 Mega Pixels at 30fps
04. Image settings	:	Compression, Color, Brightness, Sharpness, Contrast, White balance, Exposure control, Backlight compensation, WDR , Text and image overlay, Privacy mask, Noise Reduction
05. Video compression	:	H.264 high profile & M-JPEG
06. Minimum illumination	:	0 Lux-B/W 0.3 Lux-Colour
07. Video Analytics	:	Video motion detection, Active tampering alarm

08. Supported Protocol	:	IPv4, IPv6, TCP, UDP, IGMP, DHCP, FTP, SNMP(V3), SMTP, NTP, RTP, RTSP, RTCP, HTTP, HTTPS, TSL, SSL, 802.1X, QoS, PPPoE, DNS, ARP, ICMP, OnVIF Compliant.
09. Shutter time	:	1/30- 1/8,000
10. Security	:	Password protection, IP address filtering, HTTPSb encryption, IEEE 802.1Xb network access control, Digest authentication, User access log for dome type Password protection, IP address filtering, HTTPSc encryption, IEEE 802.1Xc network access control, Digest authentication, User access log for box type
11. Lens	:	Varifocal Full IR Corrected Lens of 2.8-12mm better with a coverage 20-25m coverage
12. Edge storage	:	Edge storage Support for micro SD/micro SDHC/micro SDXC card of 32 GB.Support for recording to storage
13. Power supply and Consumption	:	12V DC/24V AC or Supplier's defined voltage. 240V AC, 50 Hz supply will be provided.Approx. 5 W without IR & blower/fan
14. IP Protection	:	IP54

15. Operation Temperature & Humidity	:	0°C to 50°C, 10-90% RH (noncondensing)
16. Approvals	:	UL for Device Safety FCC for Communication Security CE for Electrical Conformity IK 8 for Vandal Proofing Protection

d) Data Sheet of Outdoor PTZ type Dome/Pendent Camera

SPECIFICATIONS	:	MINIMUM REQUIRED PARAMETERS
Optical Zoom	:	30X or higher
Digital Zoom	:	12X or higher
Presets	:	minimum of 100
Patterns	:	4
Autopans	:	4
Privacy Mask	:	4 Areas Shall Be available
Onvif	:	Profile S
Video compression	:	H.264 high profile & M-JPEG
SD card storage	:	32GB or Better
Scanning System	:	Progressive scanning
Image Sensor	:	1/3" CMOS
Video Resolution	:	3.0 Mega Pixel, @ 30fps

Aperture/Focal Length	:	f=4.3-129 mm : 30X
Sensitivity	:	Color : 0.4 Lux: BW : 0 Lux with IR ON
Shutter Speed	:	Auto: 1/25- 1/10,000s
Iris	:	Auto/Manual
Supported Protocols	:	IPv4, IPv6, TCP, UDP, IGMP, DHCP, FTP, SNMP(V3), SMTP, NTP, RTP, RTSP, RTCP, HTTP, HTTPS, TSL, SSL, 802.1X, QoS, PPPoE, DNS, ARP, ICMP, OnVIF Compliant.
Network Port	:	1 RJ45 10M/100M self-adaptive Ethernet port
Variable Speed Pan	:	0.1° ~ 180°/s; Tilt: 0.1° ~ 100°/s
Pan Travel	:	360° continuous
Tilt Travel	:	0° ~ 180° Auto Flip
Preset Accuracy	:	±0.1°
Input Voltage	:	24VAC/24VDC self-adaptive
Power Consumption:	:	<35W (IR OFF) <65W (IR ON)
Operating Temperature	:	0 degC to 50 degC
IP Protection	:	IP66
Built-in heater, air cycle system and freeze-proof	:	Shall be available

Illumination Distance of IR	:	Minimum of 100m
Operating Humidity	:	0~90%RH (non-condensing)
Defog support	:	Yes
Rating	:	IP66
Certifications	:	UL, CE, FCC, IK8

e) PC based Video Monitoring and Control Stations

The PC shall be suitable for usage on 24X7 basis. The PC shall be provided with latest configuration and technology available in the market at the time of supply. It shall include the following minimum specification –

01. Processor	:	i7 or better with 2.4 GHz or better processor
02. Memory	:	8 GB or better
03. Hard Disc drive storage	:	Min. 1 TB SATA
04. Operating system	:	Operating system as available at the time of supply but not later than Windows 2012 server edition or latest. All software shall be licensed version and license fee certificate shall be produced before product approval.
05. Network	:	Interface Card
06. Windows	:	Operating system as available at the time of supply.
07. Gigabit Ethernet	:	NIC (10/100/1000 Base T)

08. Ports	:	Min. 4 USB, 1 Serial, 1 Parallel, 1 VGA
09. Graphics card	:	Latest with minimum of 2 GB
10. Accessories	:	Keyboard, optical mouse, DVD RW
11. Monitor	:	24" LED colour monitor, as applicable with viewing angle minimum 160 degree

f) CCTV Video Storage

a. The system shall be a modular, pre-configured and pre-tested NAS/SAN storage solution capable of accommodating up to 50 TB usable in 4RU vertical rack space, using 4TB 7200 RPM or higher, 6Gbps NL-SAS drives.

b. The storage shall be scalable to 1PB usable capacity without storage controller upgrade.

c. The storage system shall support predictive analysis to identify issues before they impact system performance

d. RAID group shall be provided with RAID 6 (8+2) maximum

e. The system shall provide a proven availability greater than 99.999%

f. The storage system must be supported by a lightweight Operating System (OS) and a storage manager application, enabling storage administrators to commission new storage devices, set up network connections, provision storage and hosts, and perform various maintenance activities to manage storage arrays.

g) Intelligent/Digital Video Management Software

i) Digital video surveillance control software for Server should be capable to display and manage of surveillance system. It should provide the

flexibility to control, view and monitor the entire system from anywhere in the campus.

ii) It should manage multiple groups of users to access videos in a controlled manner. And it should also be capable of supporting variety of devices such as cameras, video industrial grade encoders, video decoders, Routers.

iii) The digital video surveillance application software should be able to view the streaming video at 1080p 25fps real time. It should also support controlling and recording up to 25 fps the video stream that is transmitted over LAN.

iv) The Digital Video recording management software shall be scalable in nature.

v) The salient features of the software are provided below.

- Multi-server video surveillance solution: Recording of video from up to 5 servers each with up to 64 IP cameras, IP video encoders per Server.
- Open Platform: Open API/SDK, supports seamless integration with third party applications
- Privacy masking shall enable administrators to conceal areas in the camera view that must not be visible or recorded in order to comply with local legislation. The privacy mask can be defined for individual cameras and is consistently applied to live, playback and exported video
- Operators may communicate with people entrances or broadcast messages to many people at once.
- Should Support ONVIF™ and PSIA compliant cameras and devices
- Optimized Recording Storage Management