TECHNICAL SPECIFICATION FOR BATTERY ENERGY STORAGE SYSTEM FOR 8MWp GRID CONNECTED SOLAR PV POWER PLANT AT NTPC, ANDAMAN

Approved by : MS		
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PART-A

PROJECT INFORMATION

CLAUSE NO	TECHNICAL SPECIFICATIONS

A-1 PROJECT INFORMATION

1.0 INTRODUCTION

Bharat Heavy Electricals Limited (BHEL) is participating in tender floated by NTPC for BATTERY ENERGY STORAGE SYSTEM FOR 8 MW SOLAR PV PROJECT AT CHIDIYATAPU IN A&N ISLANDS. Quotations are invited from eligible bidders under two part bid system for Battery Energy Storage System (BESS).

The BESS vendor scope shall cover Design, Engineering, Supply, Packaging and forwarding, Transportation, Unloading, Storage, Installation, Testing, Commissioning of 3.2 MW, 3.2 MWh (throughout life of 25 Years) Battery Energy Storage System (BESS, PCU, BMS, EMS, DC Cables, SCADA, weather prediction software, fire detection system etc., required for smooth operation) including twenty five year Operation and Maintenance (O&M) works on turnkey basis.

The following are the Supply and service Scope of BHEL and excluded from the scope of bidder in this tender:

1) All civil works required for completion of this project, including minor land levelling, container foundation, switchyard preparation, cable trenches etc.
2) AC cable for PCS Container output to transformer connection
3) Transformer
4) HT panel
5) HT cable from HT panel to metering station
6) Metering station
7) Illumination outside container units
8) 33KV grid integration

This specification is for BESS of 3.2 MW, 3.2MWh Rated Discharge AC Capacity

2.0 LOCATION AND APPROACH

District	South Andaman
Nearest Highway	NH 223
Nearest Commercial Airport	Veer Savarkar International Airport (23kms)

3.0 LAND AVAILABILITY

Land Availability	The site Chidiyatapu has approx.47 Acres of land, out of which 2500 Sq. meter is marked for BESS EPC Package.

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4.0 PROJECT CAPACITY

Name of the project	**Battery Energy Storage System for 8MW Solar PV Project at Chidiyatapu, in A&N Island**
BESS capacity	3.2 MW, 3.2MWh Rated Discharge AC capacity at 33KV interconnecting point located at 8 MW Solar PV plant side.

5.0 BESS INTERCONNECTION POINT

BESS will be interconnected with 33KV switchgear located at 8 MW Solar PV Project side.Bidder scope includes 33kV Switchgear along with interconnecting 33kV cable feeders to 8MW Solar PV Plant main polling switchgear with all associated civil and electrical works required for interfacing as indicated in tentative SLD (drawing no. 5727-004-POE-A-001 Rev B).

6.0 PERFORMANCEGUARANTEE

The guidelines of the procedure for conducting PG Test is detailed in Chapter E-4 Performance Guarantee (PG) Test.

7.0 OTHER DETAILS

SL	ITEM	DETAILS
01	Water Requirement during construction	To be arranged by BHEL
02	Power Requirement during construction	To be arranged by BHEL
03	MOEF Clearance	To be arranged by NTPC
04	SPCB Clearance	To be arranged by NTPC
05	MNRE Clearance	To be facilitated by BHEL
06	Chief Electrical Inspector clearance	To be facilitated by BHEL

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	A-2) SCOPE OF SUPPLY AND SERVICES
1.0	**INTENT OF SPECIFICATION** Battery Energy Storage System (BESS) shall provide smoothening and energy shift application for the 8 MW Solar PV plant output as specified in the specification. The scope of the proposal for the Design, Engineering, Supply, Packaging and Forwarding, Transportation, Unloading, Storage, Construction, Erection, Testing, Commissioning of grid connected Battery Energy Storage System (BESS) with minimum **3.2 MW , 3.2MWh rated AC discharge capacity at 33KV switchgear interconnection point at PV Plant throughout the life of 25 Years** and Comprehensive Operation and Maintenance (O&M) works of BESS system for a period of twenty five (25) years from the date of successful completion of trial run shall be on turnkey basis completely covering the following activities and services in respect of all the equipment & works specified and covered under the specifications and read in conjunction with “Scope of Supply & services” elaborated elsewhere. BESS system must be able to communicate with Load Dispatch Centre and control both battery system and PV plant system as per LDC requirement. The BESS shall comprises of Battery Storage system, Battery Management System (BMS), Energy Management System (EMS) & Power Conditioning System (PCS), Protection system, Solar Plant Generation Forecasting & scheduling System/Service, Communication System, HT & LT System, Auxiliary power system, Monitoring & Control system and all other associated materials and accessories necessary for trouble free operation and maintenance of the BESS system. The configuration and internal layout of the BESS shall provide suitable safe access to all equipment for installation, operation, maintenance and repair in all weather conditions. Bidder shall be responsible for identifying and providing any and all the other additional equipment, component and services necessary for its integration with the 8MW Solar PV Plant and existing ac grid, as a fully functional grid interactive BESS System. All equipment, materials and services that are necessary for the satisfactory operation of the BESS for entire O&M period of 25 years shall be deemed to be included in the scope of EPC package work and shall not be limited to the following: • Basic Engineering of the plant and systems.

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	• Detailed design, fabrication, shipping, assembling, testing, start-up, commissioning of all the equipment and system(s) including civil works. Warrant and make ready for service a fully functional turnkey battery energy storage system. • Providing for review and approval of engineering drawings, data, process calculations, test procedures, structural design calculations, Equipment layout, Drawings/Data sheets of bought out items, Civil structural/architectural Drawings, Performance & Guarantee Test procedure etc. • Complete manufacturing including conducting all type, routine and acceptance tests. Develop detailed start up and site acceptance plan. Perform factory acceptance test of the complete system. Reliability and functional guarantee tests after successful completion of trial operation. • Packing and transportation from the manufacturer's works to the site including customs clearance & port clearance, port charges, etc. • Receipt, storage, preservation and conservation of equipment at the site; Fabrication, pre-assembly, (if any), erection, testing, pre-commissioning and commissioning and putting into satisfactory operation all the equipment. • All Civil, Structural and Architectural works including construction facilities and construction power distribution. • Design, install and make ready for the electrical connections from the battery energy storage system to the 33 kV system. • Instrumentation & Communication cables and all other communication devices (at both end) required for successful integration with Solar PV plant. • Energy Management System (EMS) system for real time monitoring, operation, control, reliable & efficient operation and optimization of performance of the BESS system. • Providing Operation & Maintenance/ instruction manuals, as built drawings and other information; • Providing training of Employer's personnel.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	• Finalization of sub-vendors, manufacturing quality plans and Field quality plans. • Supply of spares. • Provide a warranty for the battery energy storage system and its constituent equipments as per technical specification. • Operation and maintenance for 25 years of the project after commissioning including replacement and disposal of batteries and other BESS equipments. • Supply any special equipment and tools required for the operation and maintenance of the project. • Decommissioning and disposal of the plant. • Satisfactory completion of the contract.
1.1	The work to be carried out as per the above scope shall be all in accordance with the requirements, conditions, appendices etc. given in Technical Specifications (Section-VI) together with those stated in other Sections/Subsections of Bid Documents which shall be considered as a part of this volumes completely as if bound herewith. It is not the intent to specify herein all aspects of design and construction nevertheless, the equipments and civil works shall conforming all aspects to high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the Employer, who will interpret the meaning of the specification and drawings and shall have a right to reject or accept any work or material which in his assessment is not complete to meet the requirements of this specification and/or applicable Indian / International standards mentioned elsewhere in this specification. The Bidder shall be responsible for providing all materials, equipment and services, specified or otherwise (unless specifically excluded) which are required to fulfill the intent of ensuring operability and the reliability of the complete system covered under this specification.
1.2	Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Such clarifications should be sought within the time period as stipulated in section ITB. Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out in his offer

	are superior to what has been specified, these may be highlighted separately.
1.3	The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of specification and ensuring operability, maintainability and the reliability of the complete work covered under this specification.
1.4	Failure of any equipment to meet the specified requirements of tests carried out at works or at site shall be sufficient cause for rejection of the equipment. Rejection of any equipment will not be held as a valid reason for delay in completion of the works as per schedule. Contractor shall be responsible for removing all deficiencies and supplying the equipment that meet the requirement.
1.5	Before submitting his bid, the bidder should inspect and examine the site and its surroundings and should satisfy himself as to the nature of the ground and subsoil, the quantities and nature of work, materials necessary for completion of the work and their availability, means of access to site and in general shall himself obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect his offer. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the Employer.
2.0.	**SCOPE OF WORK** The detailed scope of work in accordance with this specification is elaborated below. The scope of the contractor shall be deemed to include all such items which although are not specifically mentioned in the bid documents and/or in contractor's proposal but are needed to make the system complete in all respects for its safe, reliable, efficient and trouble free operation and the same shall be furnished and erected unless otherwise specifically excluded as per Section Terminal Points & Exclusions.
2.1	**ENGINEERING** Detailed design of Grid Interactive BESS for 8MW Solar PV Plant and its associated civil, electrical & mechanical auxiliary systems includes preparation of foundation drawings, single line diagrams, installation drawings, electrical layouts, design calculations etc. Project Design memorandum (PDM) and other relevant drawings and documents required for engineering of all facilities within the scope to be provided under this

contract, are covered under contractors scope of work. Submission of following document also must be included:-

- Detailed Battery & BMS schemes, logic diagrams, Architecture
- Battery system sizing calculation for all different functions
- EMS control logic diagram, schemes, architecture
- Design Philosophy of whole system
- Detailed PDM including all equipment
- Submission of Simulated study of BESS with PV plant and Grid as per specification for smoothening ,energy shift operation etc. all possible operating condition
- Earthing design and ventilation design calculation along with all associated civil design report for BESS
- Detailed O & M Manuals (02 copy) of every equipment.
- Document on Safety hazard to environment and personnel and procedure of safe disposal/handling.

2.2 **SUPPLIES & ASSOCIATED WORKS**

1. Main Equipment:-

□	Battery System.
□	Battery Management System (BMS)
□	DC Cables.
□	Power Conditioning System (PCS).
□	LT Switchgear (If required)
□	Energy Management System (EMS) & SCADA
□	Instrumentation and Communication cable

□	Grid interfacing so as to meet statutory requirements and comply with CERC code. All required hardware (AI & DI cards) etc. required for extending data to Load Dispatch Centre (LDC).
□	Solar PV Plant Generation Forecasting & Scheduling software
□	Fire Detection and protection system

CLAUSE NO	TECHNICAL SPECIFICATIONS
	2. <u>Mandatory Spares:-</u> The Bidder shall include in his scope of supply spares as described elsewhere in this tender. The specification of these spares shall be as per relevant chapter. These minimum specified spares shall be in custody of the contractor in healthy condition during complete O&M period. Contractor shall use these spares, replenish the spare(s) of the matching quality, quantity and rating within shortest possible time. **3. <u>Replacement:-</u>** The Bidder shall include in his scope of supply year wise replacement cost to fulfill the project life of 25 years. Based on the performance and end of life of the battery and other BESS components, the bidder shall consider replacement of batteries and other BESS equipment after end of life during the project tenure of 25 years.
2.3	**CIVIL WORKS – Not in bidder scope**
2.4	**OPERATION AND MAINTENANCE (O&M)** Comprehensive O&M of the BESS system for a period **of twenty five (25)** years from the date of successful completion of trial run is in the scope of the bidder. The contractor shall ensure that Battery and all other BESS components after their 'end of life' (when they become defective/ nonoperational/ non-repairable) are disposed in accordance with Latest amendment of the "E-waste (management and handling) rules, 2016" notified by Ministry of Environment, Forest and Climate Change. The plant/ system/ sub-system disposal has to be carried out by the bidder as per the procedure approved by the Employer during O&M period.

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2.5	**TRAINING OF EMPLOYERS PERSONNEL** The bidder shall provide training (free of cost) to the personnel of NTPC for 50 man-days at his manufacturing works, design office and at site for erection, testing ,FAT, commissioning and O&M. Expenses towards travel, lodging, and boarding and other expenses for the personnel shall be borne by NTPC.
2.6	**TESTING** During detailed engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification. Unless specified, the type test should have conducted within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within applicable period or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client /owners representative and submit the reports for approval. All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
2.7	**PAINTING** The bidder's scope of work includes painting of all equipment and structures as per the Employer's standard color coding scheme. The painting shall include required application of finish paint indicated elsewhere in the Technical Specification. The quality and finish of paints shall be as per standards of BIS or approved equivalent. Employer's Color Coding scheme

shall be furnished during detailed engineering stage.

2.8 PERFORMANCE GUARANTEE (PG) TEST

The performance guarantee tests shall be carried out as specified elsewhere in the Technical Specification. All special equipment, tools and tackles instruments, measuring devices required for the successful conductance of PG test shall be provided by the bidder, free of cost. All costs associated with the PG tests shall be included in bid price.

2.9 APPROVALS

The scope of the bidder includes complete design and engineering, technical coordination(including participation and arranging technical co-ordination meetings),finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by the Employer as per relevant clauses of Section VI (Technical Specifications) and other relevant clauses given elsewhere in the Technical Specifications. Further, the scope shall also include submission, in proper shape & format, of all types of manuals, handbooks & documents in requisite numbers to the Employer at different phases of the project as per the requirement of Employer. The contractor shall have to arrange technical coordination meetings and ensure participation.

3.0 CODES AND STANDARDS

All works shall be carried out as per the standards/codes (IEC, IS etc) referred in the specification. All standards, specifications and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those codes/standards referred the former shall prevail.

Equipment complying with other internationally accepted standards such as BS, UL, DIN, VDE etc. will also be considered, if they ensure performance and constructional features equivalent or superior to standards listed in the specification. In such case the Bidder shall clearly indicate the standards adopted, furnish a copy in the English of the latest revisions in force as on date of opening of bid and shall clearly bring out salient features for comparison.

The BESS and other equipment should conform to the relevant International / Indian Standards and shall meet all the CEA/CEIG and local statutory requirements for interconnection with grid at the required Voltage level.

CLAUSE NO	TECHNICAL SPECIFICATIONS
4.0	**TERMINAL POINT /POINT OF INTERCONNECTION** BESS will be interconnected with 33KV switchgear located at 8 MW Solar PV Project side. Bidder scope includes 33kV Switchgear along with interconnecting 33kV cable feeders to 8MW Solar PV Plant main polling switchgear with all associated civil and electrical works required for interfacing as indicated in tender drawing no. 5727-004(B)-POE-A-001.
5.0	**TENDER DRAWINGS** The list of drawings listed in Part-J of the Technical Specification shall form part of the specification and shall supplement the requirements specified in these technical specifications. These drawings are preliminary drawings for bidding purpose only and subject to changes that may be necessary during the detailed engineering keeping the basic parameters as specified. Various parameters for building and other equipment specified in the tender drawing are the minimum required & any increase in these parameters if required to meet the system requirement shall be made by the Bidder without any additional cost implication to Employer
5.0	**MANDATORY SPARES** The Bidder shall include in his scope of supply all the necessary Mandatory spares as described elsewhere in the specifications.
6.0	**Evaluation Criteria** The evaluation shall be made on life cycle cost basis (Capex + Opex) for period of 25 years. The Bidder shall quote as per following: a. Initial System Cost which consists of first time supply of equipments, transportation, installation and commissioning including civil works for the BESS plant. b. Year-wise investment cost which includes O&M, replacement and disposal cost year basis for a period of 25 years. c. BESS round trip AC-AC energy conversion efficiency at 33 kV bus of main switchgear of solar PV Plant . BESS System offered by bidder shall be evaluated based on Net Present Value (**NPV**) as follows: A=Initial BESS system cost per Cl. 6.0(a). B=NPV of year wise cost quoted by Bidder as per Cl. 6.0(b).

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	C=NPV of year wise recurring cost on account of energy loss due to efficiency as per Cl. 6.0 (c) . For the purpose of evaluating the revenue loss due to Cl. 6.0(c), battery utilization factor of 80% and tariff ` 10/ kWh shall be taken. Discount rate of 12% shall be considered. Total evaluated cost=**A+B+C** Further evaluations will performed as per Information to Bidder (ITB) Clause No: 25 ”Evaluation of Price Bid”.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	A-3) PROVENESS
	PROVENESS CRITERIA
1.0	The bidder/his sub-vendor(s) is required to meet the Provenness criteria a and /or qualification requirement for critical component and bought out item as per the criteria stipulated below:
1.1	**Power Conditioning System (PCS):** The bidder/ sub vendor should have manufactured grid interactive bidirectional PCS of cumulative installed capacity of 1.9 MW or higher, out of which at least one PCS installation should be of 0.6 MW capacity or higher. The reference PCS installation of 0.6 MW or higher capacity must have been in successful operation for at least six (6) months prior to the date of award of contract by BHEL to the bidder.
1.2	**Engineering Consultant/ Integrator**: If the bidder itself has not done integration of grid connected renewable energy project(s) with battery energy storage system of cumulative installed capacity of 1.9 MW or higher, out of which at least one project should be of 0.6 MW capacity or higher, in that case the bidder shall employ Engineering Consultant/ integrator who should have done integration of grid connected renewable energy project(s) with battery energy storage system of cumulative installed capacity of 1.9 MW or higher, out of which at least one project should be of 0.6 MW capacity or higher. The reference project of 0.6 MW or higher capacity must have been in successful operation for at least six (6) months prior to the date of award of contract by BHEL to the bidder. .

PART-B

DC SYSTEMS

CLAUSE NO	TECHNICAL SPECIFICATIONS

B-1 BATTERY AND BATTERY MANAGEMENT SYSTEM

1.0

GENERAL

The primary application of BESS for the current Project shall be mitigation of intermittent fluctuations of solar power generation (due to cloud, rain, tripping of solar inverter or any other reason) by smoothening of power output from the Solar PV plant and provide energy time shifting. In addition to the above two application requirement, BESS shall also have feature of manual operation, VAR support, anti-islanding operation, black start operation and frequency regulation control mode. The BESS shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed accordingly. BMS shall ensure safe operation and mitigate fire risk

BESS shall have at least twenty five (25) years of service life i.e. it should have capabilities for providing services as per specification for twenty five years from the date of successful completion of trial run. The BESS shall be configured to perform multiple charge discharge cycles. Based on the performance and end of life of the battery, the bidder shall consider replacement of the batteries after end of life during the project tenure of 25 years.

A. SOLAR GENERATION SMOOTHENING MODE:-

BESS is required to mitigate the intermittent fluctuations of solar power generation by smoothening the Solar PV plant output and deliver scheduled power (as per CERC regulation) to grid. The BESS shall absorb the short term power variations in Solar PV plant output power by fast charging or discharging the battery and generate a smoother resultant output curve that can be absorbed in the grid in an easier way. Smoothening action is to be carried out by BESS by estimating target reference power e based on 30 minutes moving average algorithm or 30 minutes moving average along with SOC control algorithm. The moving average values is the last 30 minutes average value of Solar PV plant output power. Bidder can also propose other better suitable control algorithm for this application. If alternate algorithm are proposed, then the Bidder needs to submit the supportive technical document including simulation study report for proving the superiority of the proposed alternate control algorithm over algorithm as mentioned above with respect to application requirement. The BESS shall also to have suitable control methodology to avoid unwanted charging and discharging of BESS Battery during clear sunny days without intermittency.

BESS shall ensure that the combined Solar PV and BESS output to grid (injected grid power) follows the reference target power and shall be within the band of ±5% of reference target power at any time instant for smooth injection power to grid. The reference target power in this mode shall be the 30 minutes moving average value or grid reference power set point as generated with 30 minutes moving average along with SOC control algorithm. The BESS shall operate continuously and battery SOC needs to be controlled within a certain range to prevent forced shutdown of the BESS due to overcharging or over discharging of batteries. For Energy time shifting requirement, the BESS Battery shall be sufficiently charged (subjected to sufficient power generation from solar PV plant) after mitigating intermittency and BESS shall be able to deliver at least 50% of rated 3.2MWh energy at PCC. .

B. MANUAL MODE:-

(i) The BESS operator shall be able to provide grid power set point to EMS controller through BESS SCADA HMI. BESS SCADA shall also have the facility to receive the grid power set point from LDC/Energy Management Centre and provide the same to EMS controller for necessary action.
BESS shall ensure that the combined Solar PV and BESS output to grid (injected grid power) follows the reference target power and shall be within the band of ±5% of reference target power at any time instant for smooth injection power to grid. The reference target power in this mode shall be the manual grid power set point set through SCADA HMI or set point signal as received from LDC/Energy Management Centre.

(ii) BESS operator shall be able to ramping up or down the BESS power (upto maximum BESS MW rating) by providing BESS power set point to EMS controller through BESS SCADA HMI. Once this mode is initiated, the BESS shall remain at the designated output (or input) power level until terminated by BESS SCADA with manual intervention or battery charging or discharge limit is reached.

Note for clause A & B above:-
At a time only one mode shall be active i.e. solar generation smoothening or manual mode as described in clause 1.0 A & B above and the BESS operator shall be able to select any one of the above mode based on scheduling/operational requirement. The operational & functional requirement as mentioned under the selected mode shall be applicable.

The BESS shall meet the demand upto its rated MW capacity at PCC only in case sudden dip or rise in PV plant output power more than rated capacity of BESS. Under normal operation the control of solar plant Inverters and circuit breakers are not allowed to achieve the solar power smoothening requirement as described 1.0 A & B above. However, as per grid operator requirement or under special emergency grid condition requirement the same shall be allowed for smoothening of solar PV plant output power intermittency. For this, the details control logic shall be finalized during detail engineering stage. Grid power as mentioned in clause 1.0 (A, B) shall also include local load through 33/11kV transformer as shown in tender SLD drawing.

In order to facilitate the design of smoothening requirement, the existing 5 MW NTPC-Port Blair PV plant generation output profile has been provided in Annexure-V for reference. The Bidder must take care all type of intermittency including seasonal at suitable scale in their BESS design.

C. VAR SUPPORT MODE:-

The BESS shall be required to provide VAR support to grid for voltage regulation purpose. BESS operator shall be able to provide reactive power/power factor set point to EMS controller/PCS through BESS SCADA HMI (manual intervention). BESS SCADA shall also have the facility to receive the reactive power set point from LDC/Energy Management Centre and provide the same to EMS controller/PCS for necessary action. The VAR output of the BESS may be limited based on remaining capacity left after providing real power output.

	D. ANTI-ISLANDING MODE:- The BESS shall have anti-islanding protection as per IEC 62116 or equivalent international standard. E. BLACK START/ISLAND MODE:- BESS shall have black start operation feature and shall be able to form a microgrid with solar PV plant & local loads connected at 11kV A&N switchgear. BESS shall set and automatically control the micro-grid voltage & frequency within acceptable limit and shall charge or discharge the battery based on micro-grid requirement. As per requirement BESS shall also control the active and reactive power (or power factor) of Solar PV plant by providing required set point to solar PV Inverters and also control (close/trip) the 11kV and 33kV circuit breaker located at solar PV plant end for load control purposes. BESS shall have all the required hardware, control and protection feature for safe operation of micro-grid. BESS shall also charge its battery for later use in case excess energy is available in the micro-grid after meeting the load power requirement. If the PV plant generated power is not sufficient to meet the load power requirement, then BESS shall discharge its battery to support the load power requirement. F. FREQUENCY REGULATION:- The BESS shall be able to support grid during very low or high grid frequency by supplying or absorbing power to/from grid. The power support shall be based on power vs frequency droop characteristic for system frequency outside of the predefined frequency dead band (say 49.5 to 50.5). The operation in this mode shall be initiated by detection of low or high grid frequency while the BESS is in any other mode. After normalization of grid frequency to normal operating range, the BESS shall return to the mode in which it was operating at the start of frequency regulation mode. Within the dead band frequency range the BESS do not have to participate for frequency regulation operation. During detail engineering the actual value of dead band frequency range shall be finalized based on CEA grid regulation. This mode shall be kept disable after commissioning test for the time being and Bidder needs not to consider any additional battery sizing for this application requirement G. SOLAR FORECASTING:- Bidder also has to provide solar forecasting and scheduling system/service and software tool as per CERC requirement for forecasting and scheduling for 8 MW solar PV project. The forecasting & scheduling service shall provide one day prior data and 90 minutes, 15 minutes advance data for intra-day. This system must be able to send the forecasting and scheduling data as above with Load Dispatch Centre/ Energy management Center through BESS SCADA system. The weather station input e.g. GHI, ambient temperature, humidity and wind speed, if required be shall be taken by bidder from Solar PV plant SCADA system. Alternately, Bidder can install own whether monitoring station for solar PV plant power generation forecasting purpose.
2.0	INTEGRATION WITH 8MW SOLAR PV PLANT: BESS to take (0.2S class) and (0.2 class) input signals directly from 33kV switchgear located at 8MW solar plant side for measurement of voltage, current, active power, reactive power, etc. For this, CTs spare cores at each individual 33kV feeder panels and PTs spare core at bus PT panels shall be provided at Solar PV plant side 33kV SWGR end. In total 09 numbers of 33kV feeders (located at 33kV

main switchgear of 8MW solar plant side) needs to considered for CTs & PTs input to BESS (02nos solar feeder, 02nos BESS feeder, 01 nos feeder to grid & 02 nos of transformer feeder for 11kV local load and 02 nos of spares feeder). Bidder scope also include energy meters/ transducers (0.2 class or better) as applicable for EMS controller use and shall be mounted in BESS end. Measurement of load for individual 11kV feeders located at 11kV A&N switchgear (located inside 8MW solar plant boundary) shall be directly from panel mounted MFM meter (over Modbus protocol) or numerical relay (with IEC61850 port). Supply of control & communication cable and associated cabling work (including termination etc) shall be in the BESS bidder scope.

BESS shall have facility for direct control of 8MW Solar Plant Inverters for active and reactive power control and closing and tripping of 33kV and 11kV circuit breakers for load and generation control purpose. BESS shall also be able to read and write data from/to solar SCADA server/controller as per BESS requirement. In order to meet the above requirement the BESS needs to communication with Solar PV SCADA being commissioned by NTPC. For this the BESS shall have the following provision;
The BESS SCADA LAN shall be directly connected into Solar SCADA redundant LAN at two separate Ethernet Switch located at solar SCADA control room. With this arrangement the BESS shall be able to control solar plant Inverters & VCBs and able to read and write data from/to solar SCADA server/controller.
In case the direct connection with solar SCADA LAN not possible due to protocol issue (or any other reason), then separate redundant LAN connecting solar Inverters only shall be made available by owner for BESS use. The BESS SCADA LAN shall be connected with above Solar Inverter LAN at two separate Ethernet Switch located at solar SCADA control room. In this arrangement the solar Inverters system shall be integral part of BESS SCADA LAN and direct control & monitoring of solar inverters inverter shall be possible from BESS. For solar plant VCBs control and to read and write data from/to solar SCADA server/controller the BESS shall communicate with solar SCADA with alternate (Redundant) arrangement over suitable standard protocol with no direct connection with solar SCADA LAN. In this arrangement the BESS shall also be able to provide solar inverters data including control facility to solar plant SCADA system.

All necessary software's and hardware's including laying of Communication/Fiber optic cable as required for communication with solar SCADA shall be provided by the BESS contractor. Supply of Ethernet switch at solar PV plant end is not included in the scope of BESS contractor (spare ports shall be made available). Solar inverter will have Modbus TCP/IP protocol and solar SCADA will support Modbus TCP/IP, RTU, ASCII, IEC61850, IEC60870-5-101/104, OPC-DA 2.05a protocols for integration with BESS system.

Circuit breaker at 11kV A&N switchgear shall also be control though BESS SCADA with hardwiring & 24V coupling relay or directly through soft signal via numerical relay located at 11kV switchgear. Supply of necessary control & communication cable, coupling relay, Ethernet switch etc as applicable shall be in the scope of the BESS contractor. Detail shall be finalized during details engineering stage.

3.0 BESS PARAMETER:

The following minimum parameters must be provided for technical bid evaluation. Bidder also shall submit all technical parameters so that it can be assess for all BESS functionality as mentioned above. Separate table of Functional parameters is to be submitted for each functional requirement.

S. No	Parameter	Value
1	Rated Discharge AC useful Capacity at PCC	3.2 MWh
2	Rated AC power at PCC	3.2 MW (45º C ambient temp) at 0.95 power factor.
3	BESS Round trip AC/AC Efficiency at PCC	To be specified by EPC contractor as per their BESS system in the form as provided in Section- VII (Forms and Procedures)
4	Depth of Discharge (DOD)	To be specified by EPC contractor as per their BESS system
5	Battery Efficiency (DC-DC round trip)	To be specified by EPC contractor as per their BESS system
6	Guaranteed Minimum service life	25 Years
7	Charging Rate	To be specified by EPC contractor as per their BESS system
8	Power factor (Measure at PCC)	Four quadrant capability is required. Operating power factor shall be 0.95 lead or lag.
9	Response time	Response time of BESS system shall not be more than 1 (one) second.
10	Positive and Negative Ramp Rate	BESS shall have suitable positive and negative ramp rate to support smooth injection of Solar PV plant output power into grid.
11	BESS design temperature	0º-45º C ambient

- Point of common coupling (PCC) shall be 33KV metering point located at 8 MW Solar PV Project side.
- Ambient temperature as mentioned above shall be applicable in case of conflict between ambient temperature mentioned above and those specified elsewhere in the specification.

Response time: The design of BESS system should be such that its response time shall not be more than 1 (one) sec. Response time is the time interval between need for response (a command or grid event or Solar Plant power generation event, etc) is detected by the BESS and the time when power as measured at the grid has attained that level. This shall include all intermediate response time of system components.

4.0 CODES AND STANDARDS

The BESS shall conform to the all applicable IEC/UL standard. Where an applicable IEC/UL standard is not available, IS/ any applicable international standard shall be referred to as best practice. The BESS shall meet all the CEA/CEIG and local statutory requirements for interconnection with grid at the required Voltage level.
As a minimum requirement, the following standards as applicable shall be complied with:

IEC-61427	Secondary cells and batteries for renewable energy storage for on-grid applications. Non-chemistry specific (applicable to all secondary battery types)
UL1973	Energy storage for stationary applications such as for PV. Non-chemistry specific (applicable to all secondary battery types)
IEC 62485-2	Safety requirements for secondary batteries and battery installations - to meet requirements on safety aspects associated with the erection, use, inspection, maintenance and disposal: Nonchemistry Specific (applicable to all secondary battery types)
IEC 61508	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related Systems: Applicable for all Battery Energy Storage Systems
UL 1642	Standard of Lithium Batteries (Safety of Lithium Ion Batteries)
IEC 62619	Safety requirements for large scale industrial applications.
IEC 62281	Safety of primary and secondary lithium cells and batteries during transport: Applicable for storage systems using Lithium Ion chemistries
UL9540	Safety of energy storage systems and equipments.
Grid Connectivity	Relevant CEA Regulations (including LVRT/HVRT compliance) and Grid Code as amended and revised from time to time.
Battery management and Handling rules, 2001 Ministry of Environment, Forests and Climate Change.	
E-waste (management) rules-2016 Ministry of Environment, Forest and Climate Change.	

5.0 BATTERY STORAGE SYSTEM :

The energy storage system may consist of one or more type of batteries to meet the application requirement. Battery shall be electrically interconnected in any desirable series and parallel configuration to achieve the overall system storage and power rating requirements. The DC voltage of battery system shall be selected by the Bidder to suit the PCS and battery efficient and safe operational requirement.

b. The battery cells may be supplied as separate, individual units or as group of cells combined into modules. The design, materials, and method of cell construction shall conform to the applicable code and/or standard.
c. Cell/module terminals and interconnects shall have adequate currentcarrying capacity. Labelling of the cells/modules shall include manufacturer's name, cell /module type, nameplate rating, and date of manufacture, in fully legible characters. All cells/modules shall be traceable to the point of origin for purpose of addressing safety issues. The polarities of cell/module terminal posts shall be embossed on the cover at the terminal.
d. Each electrically series-connected battery string shall include a means of disconnecting the string from the rest of the system and of providing over-current protection (during a fault).This protection shall be coordinated with the PCS capabilities and battery string protection, and shall take into account switching or other transients and the inductance/resistance (L/R) ratio at the relevant areas of the dc system. These disconnecting devices should be capable of operating with normal load current and provide physical interruption.
e. The battery system may be ungrounded or grounded. Grounded configurations may be centre or one-pole-grounded and/or solid or highresistance grounded. However, the battery system shall include a system to detect and alarm excessive ground leakage current levels. Ground fault detection shall be enabled for each container or, if more than one electrical series string is installed in the container, for each series string. The detection/trip level shall be field adjustable.
f. The cells/modules and battery system shall be supplied with all required and/or recommended accessories.
g. Cells/modules, wiring, switch gear, and all dc electrical components shall be insulated for the maximum expected voltages plus a suitable factor of safety. The dc bus work and load-carrying cables within the storage subsystem shall have an enough margin for the actual load current. Also, all other components shall have an enough margin for the actual load current according to applicable code and/or standard.
h. Battery container shall have minimum protection class IP54.
i. Suitable ventilation/controlled air conditioning and personnel safety measures in battery room/container must be maintained to minimize health hazards to any exposure to hazardous battery elements.
j. Automatic fire fighting system should be provided as per NFPA.

6.0 BATTERY MANAGEMENT SYSTEM (BMS):

The BMS shall be designed to provide for automatic, unattended operation of the battery storage system.The BMS shall provide the necessary monitoring and control to protect the battery cells/module/string from out of tolerance ambient or unsafe operating conditions. The BMS shall automatically control the charge and discharge of the individual cells/module, balancing between cells/module to optimize energy consumption and range, monitor cell/module heath and provide critical safeguards to protect the batteries from damage. BMS shall have the following feature. However Bidder to supply the BMS system as per battery OEM recommendation &requirement and shall be in line with the application requirements.

(a) Cell/module Protection :-Protecting the battery from out of tolerance operating conditions and BMS must provide full cell/module protection to cover almost any eventuality.
(b) Charge control: - BMS shall automatically control the charge and discharge of the individual cell/module.

(c) SOC Determination: - BMS shall automatically determine the State of Charge (SOC) of the individual cell/module.
(d) SOH Determination: - BMS shall automatically determine the State of Health (SOH) of the individual cell/module.
(e) Cell Balancing: - BMS shall automatically balancing between cells/modules to optimize energy consumption, range and protecting the battery.
(f) History - (Log Book Function):- Monitoring and storing the battery's parameters and communicating the same to SCADA.
(g) Alarm and fault generation and communicating the same to SCADA.
(h) Isolating the battery in cases of emergency.

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	B-2 DC CABLES
1.0	Cables used shall be of min. 1.5 kV (DC) grade. These Power cables shall have compacted Aluminum/copper conductor, XLPE insulated, PVC innersheathed (as applicable), Armoured/Unarmoured, FRLS PVC outer sheathed conforming to IS: 7098 (Part-I). These cables shall confirm to the requirements of the standards & codes specified at clause 1.0 of Chapter C4 (LT Cables) or any other relevant standard elsewhere in the specification.

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B-3 POWER CONDITIONING SYSTEM

The Power Conditioning System (PCS) is the interface between the DC battery system and the AC system and provides for charging and discharging of the battery. It may consist of one or more parallel units. The PCS shall consist of solid state electronic switch along with associated control & protection, filtering, measuring instruments and data logging devices. The PCS shall be bi-directional inverter with four quadrant operation. The PCS shall be capable to adjust the output voltage & frequency to suit the grid condition. The continuous combined rating of all PCSs shall not be less than 3.2MW at maximum operating temperature (50deg C) at 0.95 pf.

1.0 CODES AND STANDARDS

The PCS shall conform to the all applicable IEC standard. Where an applicable IEC standard is not available, IS/ any applicable international standard shall be referred to as best practice.

IEC-61683	Efficiency Measurements
IEC 61000	Emission/ Immunity requirement Harmonics
IEEE 519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IEC 60068 / IEC 62093	Environmental Testing
IEC 62116/ IEEE 1547	Protection against Islanding of Grid
IEC 62109 / IEC 62103	Safety of power converters for use in power systems
BDEW 2008	Technical Guidelines for Generating plant connected to Medium voltage network
IEEE 1547	Standard for interconnecting distributed resources with electrical power systems.
Grid Connectivity	Relevant CEA Regulations (including LVRT/HVRT compliance) and Grid Code as amended and revised from time to time.

2.0 GENERAL REQUIREMENTS

a) The PCS, in conjunction with the control system, shall be capable of completely automatic, unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect.

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	b) The PCS shall include appropriate self-protective and self-diagnostic feature to protect itself and the Battery from damage in the event of PCS component failure or from parameters beyond the PCS's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCS front panel to cause the PCS to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCS, including commutation failure, shall be cleared by the PCS protective devices. c) Troubleshooting and diagnostic tools and software shall be provided and training shall be provided to operate them. d) The PCS shall be capable of starting and operating as black start i.e., without the presence of the utility voltage. Exercise of the black start capability shall be manual and interlocked and shall under no circumstance result in an accidental energizing of the Host Utility's bus. PCS black start shall be possible from EMS without any setting modification at PCS panel locally. e) PCS must have provision to be isolated from grid through Air Circuit Breakers which shall be inbuilt with the PCS or located in separate standalone panel. f) The BESS shall have anti-islanding protection as per IEC 62116 or equivalent international standard. g) The minimum euro efficiency of the PCS as per IEC 61683 shall be 97%. The bidder shall specify the conversion efficiency at following load conditions i.e. 25%, 50%, 75% and 100% during detail engineering, which shall be confirmed by type test reports. h) The PCS shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed accordingly. i) The PCS shall have protection against any sustained fault in the feeder line and against lightning discharge in the feeder line. j) The PCS shall also have the adequate protection against earth leakage faults. k) The incoming DC feeder of PCS shall have suitably rated fuse. The PCS shall have one spare terminal with fuse and holder for the future use. l) Internal Surge Protection Device (SPD) shall be provided in the PCU on DC and AC side. It shall consist of Metal Oxide Varister (MOV) type arrestors. The discharge capability of the SPD shall be at least 10kA at 8/20 micro second wave as per IEC 61643-12. During earth fault and failure of MOV, the SPD shall safely disconnect the healthy system.

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	m) The PCS should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure long life of the inverter. n) The PCS shall have islanding and anti-islanding protection as per IEC 62116 or equivalent international standard. o) PCS shall also confirm to IEC 62109 or IEC 62103 or equivalent international standard for compliance to requirement for the design and manufacture of PCS for protection against electric shock, energy, fire, mechanical and other hazards. p) Control and read-out should be provided on the indicating panel integral to the Inverter. Display should be simple and show all the relevant parameter relating to PCS operational data and fault condition in form of front Panel meters / LED's or two line LCD Display. q) The Contractor shall ensure by carrying out all necessary studies that the PCS will not excite any resonant conditions in the system that may result in the islanded operation of PV plant and loss of generation. In case there is excitation of any resonant condition in the system during PV plant operation that may result in the islanding/tripping of the PV plant and affect the power transfer, it shall be the responsibility of contractor to rectify the design and carryout required modification in the equipment of his supply. r) In case of modular design of PCS is offered, the Contractor shall ensure that no abnormal interaction shall take place among the various PCC modules during any grid operating condition which may result in outages. The PCS controller offered by the Contactor shall be such as to ensure stability, reliability and a good dynamic performance. s) Automatic 'sleep' mode shall be provided so that unnecessary losses are minimized. t) PCS shall be designed for operating ambient temperature of 0°C to 50° C. u) The PCS shall be capable of operating in the frequency range of 47.5 Hz to 52 Hz. v) PCS current THD value shall be less than 4% at nominal load. w) PCS shall be designed for operating ambient temperature of 0°C to 50° C and humidity of 95% non-condensing. x) PCS enclosure shall be IP20 for indoor type and IP-54 or better for outdoor type. y) Outdoor PCS shall have metallic enclosure. The enclosure must be suitable to withstand the harsh environmental conditions for complete life of plant. z) PCS maximum noise level shall be 75dBA.

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	aa) PCS output current DC injection shall be less than 0.5% of nominal load current. bb) PCS Flicker shall be as per IEC61000. cc) PCS shall have active power limit control and reactive power and power factor control feature. dd) PCS shall have suitable communication port for communication with EMS. ee) The inverter shall be capable of supplying reactive power as per grid requirement (automatically or manual intervention through EMS) during normal operation. However, reactive power support, beyond 0.95 pf, might be at the behest of active power. ff) System earthing of PCS shall be applied as per recommendations of PCS manufacturer. The detail specification for panel earthing for safety has been mentioned elsewhere in this specification. gg) To prevent the maximum permissible temperature in the PCS room from being exceeded because of internal heat emission of PCS and other auxiliaries in the PCS room. The PCS room shall be adequately ventilated. The Ventilation plant capacity and air quality of inverter room shall be as per PCS and other auxiliaries' manufacturer's recommendations. Filter banks at the air inlet of the PCS room shall be provided to prevent dust ingress. Ventilation shall be designed such that the temperature rise of the inverter rooms doesn't exceed 3 deg above ambient. All exhaust and fresh air fans should be provided with thermostat control. In case Liquid cooled PCS are offered, Bidder to ensure that coolant is used in closed cycle. Complete inverter along with cooling system shall be of proven design.
3.0	**TYPE TESTING** During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last ten years from the date of techno-commercial bid opening for Owner's approval. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of techno-commercial bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

PART-C

AC SYSTEMS

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C-7 ENERGY MANAGEMENT SYSTEM

1.0 **GENERAL**

Energy Management System (EMS) system shall be a computerized system for real time monitoring, operation, control, reliable & efficient operation and optimization of performance of the BESS system. SCADA system shall be part of EMS system. EMS shall be able to acquire real time data of various equipment of BESS system and have in built logic/programming to monitor, control and optimize the performance of BESS as per specification.
Contractor shall provide complete EMS & SCADA system with all accessories, auxiliaries and associated equipments and cables for the safe, efficient and reliable operation of entire BESS and its auxiliary systems. Contractor shall include in his proposal all the Industrial Grade Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cable etc. needed for the completeness even if the same are not specifically appearing in this specifications.

a) EMS shall have provision to control the BESS equipments as per requirement mentioned in respective chapter. EMS shall be able to acquire real time Data, Status and Alarm from following equipment, but not limited to as required or offered under the scope of this specification
   - i. All the LV/MV Switchgear Equipments /panels including solar plant and A & N distribution switchgear equipment.
   - ii. UPS and Battery charger as approved in detail Engineering
   - iii. Energy Meter/MFM/Power Meter/transducer
   - iv. Numerical Relay
   - v. PCS
   - vi. Fire Protection System
   - vii. GPS Time Synchronisation unit
   - viii. BMS system ix. Transformer
   - x. Any other equipment as offered by contractor.

b) EMS shall perform the following functions,
   - i. Real-time acquisition and display of data, status, alarms and trends.
   - ii. Display BESS system data suitable for operation and fault finding, including diagnostics and self-check functions.
   - iii. Operate the BESS as per application requirement.
   - iv. Display of status of major equipments in Single Line Diagram (SLD) format.

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	v. Logic functions for control, protection and annunciation of the equipments and systems. vi. Allow local control of the BESS, such as providing charge and discharge set points and setting of ramp rates. vii. Allow selection of BESS operation mode. viii. Control of switchgears and PCS. ix. Display and storage of measured values. x. Historical storage of important data. xi. Display and storage of derived/calculated/integrated values. xii. Display and Storage of Alarm, Event and Trends xiii. Generate, store and retrieve user configurable Sequence of Event (SOE) Reports xiv. Generate, store and retrieve user configurable periodic Reports. It shall have facility to generate report in MS Excel format. xv. Generation control and scheduling of Generation as per CEA regulation. xvi. Remote monitoring of essential parameters on the web authorised with user id and password using standard modem (Internet connection for transferring data to web shall be taken by Contractor in the name of NTPC Site for O & M period). xvii. Communication with Solar PV SCADA being commissioned by NTPC. All necessary software and hardware (both end) including laying of Communication/Fiber optic cable as required for communication solar SCADA shall be provided by the contractor. xviii. It shall support following standard protocols (included but not limited to) to communicate with different sub system/Devices. a) Modbus (TCP/IP, RTU, ASCII) b) Sub Station Protocol such as IEC- 61850, IEC 60870 -5-101//104 xix. System self-supervision and diagnostic functions xx. Security of Data from authorized access using Hardware Firewall and software access privileges/rights. xxi. Auto logging of all O & M evaluation parameters like availability, daily capacity used etc. in report form so that it can be handed over to NTPC personnel for review. xxii. Auto generated reports to evaluate the performances of BESS for all functions like smoothening, time shift operations etc. as mentioned elsewhere in this specification c) Contractor shall provide a Package/Split AC of suitable capacity decided by load requirement in EMS (SCADA) room. d) The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the

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	safety of plant, personnel or equipment is affected. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering. e) The SCADA (including EMS) system shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. f) The memory shall be field expandable. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% expansion in future. Programmed operating sequences and criteria shall be stored in nonvolatile semiconductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup for at least 360 hours. The batteries shall be lithium or Ni-Cd type. g) 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. h) 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.
3.0	**HUMAN MACHINE INTERFACE SYSTEM (HMIS)** The EMS (SCADA) shall be OPC version 2.05a compliant and implement an OPC-DA2.05a server as per the specification of OPC Foundation. All data should be accessible through this OPC server. Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all devices interacting with control system. Contractor shall provide engineering workstation (EWS) as programming station of the EMS. It shall be possible to use same EWS as programming station and the Human Machine Interface System. SCADA System shall be provided with redundant OWS. Operator shall be able to access all control/information related data under all operating conditions including a single processor and computer failure/hardware failure at main control room in the HMIS. In addition to a desktop based EWS, vendor shall also provide dedicated portable (laptop) based EWS. All frequently called important functions including major displays shall be assigned to dedicated

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	function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions. The EMS (SCADA) System shall have ability to perform operator functions for each OWS / GIU as a minimum, include Control System operation (A/M selection, raise/lower, set point/bias change, on/off, open/close operation, mode/device selection, bypassing criteria, sequence auto, start/stop selection, drive auto selection, local-remote/other multi-position selection etc.); alarm acknowledge; call all kind of displays, logs, summaries, calculation results, etc.; printing of logs & reports; retrieval of historical data; and any other functions required for smooth operation, control & management of information as finalized during detailed engineering. The display selection process shall be optimized so that the desired display can be selected with the minimum no. of operations. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets. The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. Assignment of allowable functions and entry fields shall be on the basis of user profile. The system security shall contain various user levels with specific rights as finalized by the Employer during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator). Wherever Graphical Interface Unit is envisaged, it shall meet the minimum functional requirements of monitoring, operating & controlling the process and displaying information related to process locally. GIU shall be provided with TFT active matrix or LED display and keypad for operation. GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration. In addition to GUI Display, one 50 Inch LED display shall be provided at EMS Room. Remote monitoring of essential parameters on the World Wide Web using standard modem and Popular Browser such Chrome/Internet Explorer shall be provided by the vendor.(Internet connection for transferring data to web shall be taken by Contractor in the name of NTPC Site for O & M period). Bidder has to provide suitable hardware firewall to restrict unauthorized access to HMI/EMS (SCADA) PCs.
4.0	**SOFTWARE REQUIREMENT** All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided. The programs shall include high level languages as far as possible. The contractor shall provide sufficient documentation and program

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	listing so that it is possible for the Employer to carry out modification at a later date. The Contractor shall provide all software required by the system for meeting the intent and functional/parametric requirements of the specification. Industry standard operating system like WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry. The system shall have user friendly programming language & graphic user interface. All system related software including Real Time Operating System, File management software, screen editor, database management software, On line diagnostics/debug software, peripheral drivers software and latest versions of standard PC-based software and latest WINDOWS based packages (MS Word, Excel and PowerPoint) etc. and any other standard language offered shall be furnished as a minimum.
5.0	**HISTORICAL STORAGE AND RETRIEVAL SYSTEM (HSRS)** The HSRS shall collect, store and process system data from MMIPIS data base. The data shall be saved online on hard disk and automatically transferred to erasable long term storage media once in a week periodically for long term storage. Provision shall be made to notify the operator when hard disk is certain percentage full. The disk capacity shall be sufficient to store at least one year data. The data to be stored in the above system shall include alarm and event list, periodic plant data, selected logs/reports. The data/information to be stored & frequency of storage and retrieval shall be as finalised during detailed engineering. The system shall provide user-friendly operator functions to retrieve the data from historical storage. It shall be possible to retrieve the selected data on OWS or printer in form of trend/report by specifying date, time & period. Further, suitable index files/directories shall also be provided to facilitate the same. The logs/reports for at least one year shall be available on the disk. In addition to above, the system shall also have facility to store & retrieve important plant data for a very long duration (plant life) on portable long term storage media). These data will include any data from the database as well as processed/computed data based various calculations/ transformation. The retrieved data from long term storage media should be possible to be presented in form of alarms, logs, reports, etc. EMS shall have facility to store long term data, days wise/ weekly/ monthly/yearly for 25 years for analysis and analytical reports to analyze the plant performance at various levels. For faster retrieval of long term aforementioned performance data, contractor shall offer time series data historian or separate database on the workstation.

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Following plant data as a minimum with time stamping and interval as indicated in below table but not limited to shall be stored daily on historian for analysis and analytic report. Details requirement shall be finalized during detail engineering stage.

Sl.	Parameter	Time Interval
1	(i) Active power of all 33KV switchgear feeders located at solar PV plants end and BESS plant end. (ii) Reference target power Any other data required for evaluation of smoothening function.	1 (One) Sec
2	Other EMS & SCADA data	1 (One) Minute
2	Grid Voltage and frequency	1 (One) Sec
3	PCS data	1 (One) Minute
4	MFM and Energy meter data	1 (One) Minute
5	Important BMS data	1 (One) Minute
6	Other important data	1 (One) Minute

6.0 CONTROL & POWER SUPPLY SCHEME

Contractor shall provide the UPS/ DC Power supply of suitable rating to cater all the load requirements of EMS system and its auxiliaries. The details of UPS/ DC Power supply are mentioned in the respective clause of this specification.

7.0 CONTROL CABINETS / PANELS / DESKS AT EMS ROOM

The cabinets shall be IP-22 or better protection class. The Contractor shall ensure that the packaging density of equipment in these cabinets is not excessive and abnormal temperature rise, above the cabinet temperature during normal operation or air-conditioning failure, is prevented by careful design. This shall be demonstrated to the Employer during the factory testing of the system. The Contractor shall ensure that the temperature rise is limited to 10 deg. C above ambient and is well within the safe limits for system components even under the worst condition and specification requirements for remote I/O cabinets. Ventilation blowers shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent. If blowers are required for satisfactory system operation, dual blowers with blower failure alarm shall be provided in each cabinet with

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	proper enclosure and details shall be furnished with proposal. Suitable louvers with wire mesh shall be provided on the cabinet.. The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet shall not higher than 2200 mm. The cabinets shall be equipped with full height front and rear doors. The floor mounting arrangement for other cabinets shall be as required by the Employer and shall be furnished by the Contractor during detailed engineering.
8.0	**CONTROL DESK** Control desk shall be free standing table top type with doors at the back and shall be constructed of 2mm thick CRCA steel plates. A 19 mm thick wooden top shall be provided on the desk to keep the TFT monitors at top and computers inside. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, mouse pads, monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal and vertical directions. Telephone sets, very few PB stations and lamps shall be mounted on the control desk on mosaic grid structure and same shall be decided during detailed engineering.
9.0	**FURNITURE** Chairs – Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area (At least 4 Nos). These shall be designed for sitting for long duration such that these are comfortable for the back. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. One Printer Table made of Laminated Wood or Heavy Duty MDF shall be provided for printer. All the furniture shall be of reputed make (Godrej or Equivalent).
10.0	**SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS** All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the EMS System shall be furnished. The Contractor shall furnish a comprehensive list of all system/application software documentation after system organization for Employer's review and approval. All The software listings for application software, Project data files etc. shall be submitted by the Contractor. All the EMS Software with license Key shall be handed over

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	to BHEL/ NTPC on the DVD/CD media. All the hardware and software shall be licensed to NTPC.
11.0	**SOFTWARE LICENCES** The Contractor shall provide software license for all software being used in Contractor's System. The software licenses shall be provided for the project (e.g. organization or site license) and shall not be hardware/machinespecific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for Employer to seek a new license/renew license due to up gradation/change of hardware/machine in Contractor's System at site. All licenses shall be valid for the continuous service life of the plant. Contractor shall provide Minimum **6 nos** of licenses for remote monitoring (Concurrent viewing of data at **6** different locations authorized with user ID/ Password) of the essential parameters of BESS plant on the web using popular web browser without requirement of additional software. User ID and password for remote view can only be changed by SCADA Administrator. Also it shall be possible to download reports from a remote web-client in Excel format.
12.0	. **HMIPIS HARDWARE** The HMIPIS as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment. The Workstation/Servers employed for HMIPIS implementation shall be redundant based on industry standard hardware and software which will ensure easy connectivity with other systems and portability of Employer developed and third party software. Redundant sets of communication controllers shall be provided to handle all the communication between the HMIPIS and redundant system bus and to ensure specified system response time and parametric requirements. Each communication controller shall have message checking facility. Power Fail Auto Restart (PFAR) facility with automatic time update shall be provided. All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Employer during detailed engineering. Industrial grade Managed Ethernet switch shall be used for EMS system and recovery time shall be less than 50ms.

CLAUSE NO	TECHNICAL SPECIFICATIONS

Operator Workstations/Historian/Portable EWS

Sl No.	Features	Industrial Grade Operator workstations/ Other workstations/ Documentation station (in case not part of prog. Stn.)
1.	Processor	64 bit(i5 or Equivalent)
2.	Memory	8 GB RAM upgradable to 16 GB
3.	Hard Disk	500 GB ultra wide RAID1 for OWS/ 500 GB for Portable EWS 1 TB ultra wide RAID1 for Historian
4.	Monitor (color)	Min 23" TFT Flat Monitor with non-interfaced refresh rate min. 75 Hz. **Communication port:-** 2 Serial bus , one parallel Dual 10/100/1000 Mbps. Ethernet Graphic Memory = 16 MB Expansion slot=3
5.	Removable bulk storage drive (DVD / DAT)	6 GB (minimum)
6.	DVD R/W	16x or higher
7.	Keyboard	ASCII
8.	Pointing Device	Mouse
9.	Additional general purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/antivirus, etc.

CLAUSE NO	TECHNICAL SPECIFICATIONS

10.	Software	MS. Windows latest, MS Office Editor (EXCEL,WORD, POWER POINT), Adobe Acrobat, Anti Virus, Network Security, Etc.

Engineering Cum Operator Workstations

SI No.	Features	Industrial Server Grade Engineering cum Operator workstations
1.	Processor	64 bit Server Grade (Xeon or Equivalent), Octacore minimum
2.	Memory	16 GB RAM upgradable to 24 GB
3.	Hard Disk	1 TB RAID1
4.	Monitor (color)	Min 23" TFT Flat Monitor with non-interfaced refresh rate min. 75 Hz. **Communication port:-** 2 Serial bus , one parallel Dual 10/100/1000 Mbps. Ethernet Graphic Memory = 16 MB, Expansion slot=3
5.	Removable bulk storage drive (DVD / DAT)	6 GB (minimum)
6.	Portable Bulk Storage Media	2 TB (2 nos.)
7.	DVD R/W	16x or higher
9.	Keyboard	ASCII
10.	Pointing Device	Mouse

CLAUSE NO	TECHNICAL SPECIFICATIONS

12.	Additional general purpose software (for using over network by servers/workstations/PCs)	Comprehensive disk maintenance utility for disk clean sweep/ crash guard/antivirus, etc.
13.	Software	MS Windows latest, MS Office, Adobe PDF Reader, Anti Virus, Network Security Etc.

LED Display

1	LED Display	50 Inch LED Display, Display Resolution : 1920 x 1080, Wall Mounted, Reputed make (Samsung/Sony/LG or Equivalent)

Printer – 1 no.

Sr	Features	Networked Colour Laser Printer
1	Paper Size	A3
2	Printing Speed (min.)- in normal mode for A4 size paper	6 ppm (Color)
		24 ppm (B&W)
3	Type	Heavy duty, least 50000 at pages/month
4	Resolution (black) (min.)	600 dpi
5	First page out time (with full graphic display)	=<1 min for color,
		<45 sec for BW
6	Paper input capacity (min.)	500 sheets
7	Additional features	Automatic Duplex Printing
8		10 reams (A3)

	Paper sheets (1 ream = 500 sheets) withprinter (To be supplied with printer)	20 reams (A4)

13.0 INTERFACE WITH NTPC PI SERVER

For communicating the BESS plant data in NTPC, the BESS system shall be interfaced/ connected **PI server of NTPC on OPC Protocol.** The details of NTPC PI server shall be furnished during the detailed engineering.

14.0 TELEMETRY REQUIREMENT FOR LDC

The arrangement to transmit the BESS data required by the Load Dispatch Centre (LDC), as per as per CERC/Local Utility regulations or procedures for grid management is in the scope of contractor. All necessary software and hardware including laying of Communication/Fiber optic cable/wireless link as required for transmitting the data shall be provided by the contractor at both end (BESS and LDC). Communication fiber optic cable laying if any shall be limited to within solar PV plant boundary.

15.0 TIME SYNCHRONIZATION

The contractor will provide at least one GPS clock, which shall be synchronized with the EMS system and all devices (time synchronizable) which are communicating with EMS shall be synchronized with GPS Clock through EMS or directly with GPS Clock. The technical details of GPS has been specified elsewhere in the specification.

a) Time Synchronization equipments shall be provided and shall be located in the Control Room. It shall receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization components of the EMS.

b) It shall be complete in all respects including antenna, all cables, processing equipment, etc.

c) All auxiliary systems and special cables required for synchronization of the equipment shall be supplied and commissioned by the Contractor.

d) It shall work from DC supplies only and the Contractor to clarify if any built-in battery backup is provided, in which case, same shall be of long life lithium batteries.

e) It shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and overvoltages in power supply systems and antenna feeders.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	f) The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255. g) All components of the EMS as per requirement under this scope of technical specification or offered by bidder shall be synchronized with an accuracy of 1ms. h) The GPS shall be synchronized with the EMS system to be supplied under this contract and all devices which are communicating with EMS shall be synchronized with GPS. Necessary software and Hardware (including laying of communication cable) required for time synchronization with EMS and all other devises shall be in scope of contractor. i) The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals. j) The system shall have provisions for combination of any of the following output signals: • NTP (network time protocol) 100Mbits Ethernet port • IRIG-B00x (TTL, pulse width modulated signal) • 2 x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts • Any other output port as may be required for the offered system. • Alarm status contact indicating healthy status of system k) These output ports shall be compatible with the requirement of the equipment to be synchronized. The master clock in control room shall also be synchronized with the time synchronization system. The actual port requirements (no./type) in line with the system offered shall be finalized during detailed engineering. The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24 hour mode) and have a separate time display, having display size of approx. 144mm height
16.0	**FACTORY ACCEPTANCE TEST (FAT)** FAT procedure for EMS shall be submitted by bidder for BHEL/NTPC approval and after approval of FAT procedure, FAT will be witnessed by BHEL/NTPC Engineering or authorized representative of BHEL/NTPC.
17.0	**PARAMETRIC REQUIREMENT** The SCADA control system shall be designed such that under worst case loading conditions the response time shall not be worst than the following: **On/Off command**- The response time for screen update after the execution of the control command from the time the command is issued shall be one second (excluding the drive actuation time) **Adjustment command**- 0.5 to 1 second **On screen updating-** 1 Second **All control related display-** 1 Second

Bar Chart displays- 1 to 2 seconds

Plant mimic displays- 1 to 2 seconds

Group review displays- 1 to 2 seconds

X-T plot display- 1 to 2 seconds

Plant summary displays- 1 to 2 seconds

Even under worst case loading conditions of HMIS and system Bus, each HMIS processor shall have 50% spare time when measured over any one minute period and the system Bus shall have at least 50% spare duty cycle.

SCADA INPUT/OUTPUT MODULES

18.0 SCADA input output modules, as required in the control system for all type of field input signals (4-20 mA, non-changeover/change over type of contact inputs etc.,) and inputs from the control system (non change over/change over type of contact, output signals for energizing interface relays at suitable DC voltage as decided during detail engineering, 4-20 mA, output etc.,) are to be provided by the contractor

Electrical isolation of 1.5kV with optical couplers between the plant input/output and controller shall be provided on the I/O cards. The isolation shall insure that any inadvertent voltage are voltage spikes (as may be encountered in a plant of this nature) shall not damage or mal-operate the internal processing equipment. The input/output system shall facilitate modular expansion fixed stages. The individual input/output cards shall incorporate indications on the modules front panels for displaying individual singer statues.

Individually fused output circuits with the blower fuse indicator shall be provided. All input/ output points shall we provided with status indicator. Input circuits shall be provided with fuses preferably for each input alternatively suitable combination of inputs shall be done and provided with fuses that for any fault, fuse failure shall effect the particular drive/equipment system only without affecting other systems.

All input/output cards shall have quick disconnect termination allowing for card replacement without disconnection of external wiring and without switching of power supply.

The I/O Module shall have the following features:

a	Power supply monitoring
b	Contact bounce filtering.
c	Optical isolation b/w I/O signals with internal circuits.
d	In case of power supply failure are hardware fault, the critical outputs shall be automatically switch to the fail-safe mode. The fail-safe mode shall be finalized during detailed engineering.

Binary output modules shall be rated to switch ON/OFF coupling capacitor relays approx, 3 V/A. Analog output modules shall be able to drive a load impedance 500 ohms minimum.

Output module shall be capable of switching ON/OFF indicative loads like auxiliary relays etc. Without any hardware.

All input field integration voltage shall be finalized during detailed engineering in case of loss off I/O Communication link with the main processing unit, the I/O shall be able to go to predetermined fail safe mode (to be finalized during detailed engineering) With proper annunciation.

The single (i/e non-redundant) binary & analog signal required for control purposes shall be wired as follows:

All single analog &binary inputs including limit switches of SWGR.Check-backs of all drives &information related signals shall be wired to signal (i/e non-redundant) input modules.

Inputs & outputs related to each redundant drives /equipments shall be wired to separate input and output modules.

SYSTEM SPARE CAPACITY

19.0

Over and above the equipment and accessories required to meet the fully implemented system as per specifications requirements, control system shall have spare capacity and necessary hardware/equipment/accessories to meet following requirement for future expansion at site:

20% spare Challan in I/O modules wired up to cabinets TB. Wired-in “usable” space for 20% modules in each of the systems cabinets for mounting electronic modules wired up to corresponding spare terminals in systems cabinets. Empty slots b/w individual modules/ group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of contractor shall not be considered as wired-in “usable “space for I/O modules .Terminal assemblies (if any in the offered system), corresponding to the I/O processor / controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops. Further each processor/controller shall have spare capacity to handle to minimum 30% additional inputs/outputs of each type including about speficed spare requirement, over and above implemented capacity. Each of the corresponding communication shall also have same spare capacity as that of processor/controller.

The Data communication system shall have the capacity to handle the additions mentioned above. Twenty (20) percent spare relays of each type and rating mounted and wired in cabinets TB. All contacts of relays shall be terminated in terminal blocks of cabinets.

The spare capacity as specified above shall be uniformly distributed throughout all cubicles. The System design shall ensure that above mentioned additions shall not require any additional controller/processor/peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time/duty cycle, etc. From those stipulated under specification.

DATA COMMUNICATION SYSTEM (DCS)

20.0

The date communication system shall include redundant main system bus with hot back-up. Other applicable systems like cubicle bus, local bus, I/O bus etc. Shall be redundant except for backplane buses which can be non-redundant.

a.) Redundant communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) controllers and operator work station.

b.) The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than the single message to be disrupted and that message shall automatically be transmitted. Any failure are physical of any removal of station-Module connected to the system bus shall not result in loss of any communication function to and from any other station-Module.

c.) If the system bus requires a master bus controller philosophy, it shall employ redundant master bus controller with automatic switchover facility.

d.) Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the same shall be suitably alarmed/logged.

e.) The design and installation of the system bus shall take care of the environmental conditions as applicable.

f.) Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion.

g.) Cat 6 UTP or fiber optic cables shall be employed.

The contractor shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.

Contractor shall provide redundant OFC communication link/backbone between local SCADA panels and main control room with ring topology or better to the approved during detail engineering.

Each Modbus cable shall be provided with surge protection device at SCADA panel End. Specification of OFC and Modbus cable has been given elsewhere in this specification.

21.0 OPEREATOR INTERFACE DISPLAYS/LOGS/REPORTS

Suitable operator interface displays/log/reports for control operation and monitoring shall be provided. The details shall be finalized during detailed ENGG stage.

Minimum quantities shall be as follows:-

Various displays on the OWS shall as a minimum include P&ID displays or mimic, bar chart displays, X-Y & X-T plot (trend) displays, operator guidance message displays, group displays, plant start-up/shutdown message displays, system status displays etc. number of displays and the exact functionality shall be honest required basis on finalized during detailed engineering subject to the minimum quantities as given it subsequent clauses. For X-T & X-Y plots, the facility of providing a background grid on operator request shall be variable with adequate no. of divisions in both co-ordinates.

The minimum quantity of major types of displays for unit shall as follows.

Sl No	Display	Minimum Quantity

a)	Control displays(group/sub-group/sequence/loop)	(on as reqd. basis subject to 1000 minimum)
b)	P & ID/mimic display	25
c)	X-Y plot(with superimposed operating curves + using user selectable stored data)	25+25
d)	Group displays	30
e)	Operator guidance message	20
f)	System status & other diagnostic display	On as required basis

The assignment for the above will be done by the contractor as per the requirement of operation of contractor's system as well as for maintenance. The balance displays shall be left as spare for future modification/addition.

PART-E

GENERAL SYSTEMS

CLAUSE NO	TECHNICAL SPECIFICATIONS

E-1 FIRE FIGHTING AND ALARM SYSTEM

The BESS plant shall be equipped with suitable Fire Alarm systems meeting the CEIG requirement for Battery yard/Container, Switchgear room, Equipment room, Store room/ shed & Control room etc as required in the scope or offered by the contractor.

All the fire equipments to be supplied shall be certified product suitable for operating temperature of 0-55 Deg C in general and/or 0-49 Deg C if UL(US) certified .

1.0 Bidder shall comply with recommendation of Tariff Advisory Committee to incurring minimal premium for insurance. The installation shall meet all applicable statutory requirements, safety regulations in terms of fire protection.

2.0 The fire fighting system for the proposed power plant for fire protection shall be consisting of:

a) Sand buckets
b) Portable fire extinguishers
c) Microprocessor based fire alarm panel.

2.1 **Portable Fire Extinguishers and Sand Buckets**

Bidder to provide following numbers of type tested portable fire extinguishers as per relevant code in the rooms/location included but not limited as indicated below.

Rooms	**DCP Type (ABC type) (10 Kg. Capacity)**	**CO_2 Type 9 kg capacity**	**Foam Type Hand 9 kg**	**Hand Portable pressurized water $C0_2$ 9 Litre**	**Sand Buckets**
Control Room	2	2		2	2
All Electrical Equipment /Switchgear Room	1	1			
EMS Room		2			
Each Oil Transformer Yard	1	1	1		2

CLAUSE NO	TECHNICAL SPECIFICATIONS

Security Room		1		2	
Storage Shed	1	1	1	1	2
Battery yard (Per 100 SQM of Area)	1	1	1		2

Fire protection/ alarm system for the Batteries shall be proven & certified and shall be duly endorsed by the battery OEM.

2.2

Microprocessor based fire alarm panel

Bidder to provide intelligent microprocessor based main fire alarm panel and sensor of modular construction complete with central processing unit, input and output modules, power supply module, supervision control and isolator modules with 10% spare provisions in each loop. Fire detection alarm system shall include but not limited to the following items.

1. Fire Alarm control Panel
2. Multi Sensor smoke detector
3. Heat Detectors
4. Hooter cum strobe (Outdoor Duty)
5. Manual call Point
6. Hooter
7. Fault isolation modules
8. Control Modules
9. Cables from Sensors to Fire panels.
10. Digital output from the fire detection system shall be integrated with SCADA
11. Network Module
12. Interfacing of Fire Alarm System with SCADA for display and storage of status and alarm in SCADA

Multi sensor type smoke detectors shall be provided at all the indoor locations housing Electrical equipment /Spares .Detectors shall be provided below false ceiling wherever applicable. All the cable trench inside the control room and inverter room shall be provided with smoke detector.

Fault Isolation module shall be provided in every room and for every 15 sensors at location proposed by Bidder to be approved by employer during detail engineering.

Fire Alarm Control Panel Indication

CLAUSE NO	TECHNICAL SPECIFICATIONS
	i. Alarm conditions shall be immediately displayed on the control panel and in SCADA. Alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged the LED shall remain lit. A subsequent alarm received from another zone after acknowledgement shall illuminate the alarm LED and the panel display shall show the new alarm information. ii. During an alarm condition, an alarm tone shall sound within the control panel until the alarm is acknowledged. iii. If the audible alarm signals are silenced for any reason, they shall automatically resound if another zone is activated. iv. All alarm signals shall be automatically "locked in" at the control panel until the operated device is returned to its normal condition and the control panel is manually reset There shall be weather proof Hooter cum strobe outside and hooter inside each Indoor location for indication of fire alarm for respective zone/area at suitable location. All the hardware, relay and accessories required for completeness of fire alarm system is in Bidder scope. Fire alarm system shall have its own battery and charger and it shall be provided power from UPS DB. Each location with fire sensors shall be also be provided with manual call point, Alarm acknowledge and reset facility for alarm for respective zone only. Bidder shall submit document to employer for approval that will include fire alarm system configuration, layout, BoM, Datasheet and necessary test report. Bidder shall consider 30 % design and aging margin for selection of nos. of sensors in each loop and length of each loop. Bidder shall submit the certificate from OEM indicating maximum nos. of sensors in single loop and maximum length of single loop allowed with offered panel and type of cable to be used for sensor. BoM of the Fire alarm system shall be reviewed /Endorsed by the OEM of Fire Alarm System. Fire Alarm Control Panel for loop provided in Main Control room shall be kept at Main control room. Bidder shall submit Site Acceptance Test (SAT) for approval by employer. Complete fire alarm system shall be checked at site for verification of faithful performance and completeness of the system. Bidder shall carry out necessary modification and supply hardware/accessories if required free of cost at site.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	E-2 TRIAL RUN & OTHER GENERAL REQUIREMENTS
1.0	**TRIAL RUN** BESS Plant site shall be deemed to be successfully erected & commissioned after submission of relevant commissioning certificate from owner. During the trial operation, BESS plant shall perform trouble-free operation for cumulative 36 hours during which functionality of all plant components shall be demonstrated and the system shall be in export/import Mode. During trial BESS should be able generate the name plate power continuously for one hours.
2.0	**WARRANTY** The battery and other BESS components shall be warranted by bidder as per Annexure-7P Section - VII- (Forms & Procedures) regarding warranty requirement. The Equipment Warranty period shall also commence from the date of successful completion of trial run.
3.0	**INSURANCE** The bidder's insurance liabilities pertaining to the scope of works are detailed out in Clauses titled Insurance in General Conditions of Contract. The bidder's insurance liabilities during O&M period has been brought out in Chapter E-3 Clause 4.0.
4.0	**TAKING OVER** Upon successful completion of all the facilities pertaining to the scope of work contractor shall approach the owner in writing for "final take over" of the plant. On receipt of such request, owner shall issue to the contractor a taking over certificate as a proof of the final acceptance of the system. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	E-3 OPERATION AND MAINTENANCE
1.0	The successful bidder shall provide Operation and maintenance of BESS Plant along with grid connecting system which are presently included in bidder's scope of supply and installation, for a period of **twenty five** (25) years from date of successful completion of trial run. During O&M period, BHEL/NTPC personnel shall have unrestricted entry to the solar plant and Control Room any time. BHEL/NTPC may suitably depute its personals to associate with O&M activities. Contractor shall assist them in developing expertise through their day to day O&M activities. All records of maintenance must be maintained by the contractor which can be accessed by BHEL/NTPC on demand. These records are to be handed over to BHEL/NTPC after the O&M period of contract. Based on the performance and end of life of the batteries and other BESS equipment, the bidder shall consider replacement after end of life during the project tenure of 25 years. The plant/ system/ sub-system disposal has to be carried out by the bidder as per the procedure approved by the Employer during O&M period.
2.0	The bidder shall be responsible for supply of all spare parts, repairs / replacement of any defective equipment(s) at his own cost as required from time to time during the O&M period. Bidder to ensure that the safety practices outlined by Battery manufacturer for handling battery to be strictly followed. Bidder also to provide first aid/safety measures at suitable locations to minimize health risk of the personnel involved in battery O&M.
3.0	The contractor shall be responsible for the Operation and Maintenance of the entire BESS plant during the O&M period. The brief scope of works is listed below. The details shall be further elaborated by the bidder in the O&M manual to be submitted to BHEL/NTPC for approval. (a) Ensuring successful operation of BESS plant for optimum use. (b) Ensuring Breakdown maintenance, Preventive maintenance overhauls, Arranging visit of O&M experts (when required) to maximize the availability of BESS plant. (c) Daily work of the operators involves logging important parameter of BESS system/equipments. (d) Submission of periodical reports to the owner on operating conditions of the BESS. (e) Ensuring Safety and protection of the plant by deputing sufficient security personals (f) Monitoring, controlling, troubleshooting, maintaining of records, registers. (g) Supply of all type of spares, consumables and fixing / application of the same.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	(h) Cleaning of the plant including battery yard on regular basis and as and when required. (i) Cleaning of drains, cable trenches, box culverts etc (j) Herbicide spray and grass cutting on a periodic basis (k) The contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules. (l) The Contractor shall ensure that all safety measures are taken at the site to avoid accidents to his employees or his Co-contractor's employees (m) The Contractor shall immediately report the accidents, if any, to the Engineer In charge & to all the concerned authorities as per prevailing laws of the state. (n) The Contractor shall comply with the provision of all relevant Acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Employees State Insurance Act 1948, Contract Labor (Regulations & Abolishment) Act 1970 or any modification thereof or any other law relating whereto and rules made there under from time to time. (o) In order to ensure longevity, safety of the core equipment and optimum performance of the system the contractor should use only genuine spares of high quality standards. (p) Deployment of Plant in Charge, adequate number of technical support staff and other supporting personnel during the O&M period (q) Bidder is required to maintain adequate O&M spare during the O&M contract period of the BESS plant with the view to maximize availability of the plant. . (r) Bidder has to take Comprehensive Annual Maintenance Contract (AMC) from OEM for the following components: • PCS System • EMS and SCADA • Battery and BMS system The AMC document has to be submitted before completion of trial run. (s) Contractor shall be responsible to carry out all test and work as required by statutory regulation in effect as on date of Technocommercial bid opening during O&M period. (t) Contractor shall be responsible to carry out 33kV switchgear numerical relay testing and interlock checking once in every year. (u) Relay setting and logic modification as per BHEL/NTPC requirement needs to be carried as and when required.

CLAUSE NO	TECHNICAL SPECIFICATIONS
	(v) Contractor shall be responsible to carry out minor wiring modification if required during O&M period. (w) Any other works which are necessary for successful and smooth operation of BESS system shall be included in the scope of the contractor.
4.0	**Decommissioning** A decommissioning/disposal plan shall be included as part of the operations and maintenance documentation. The decommissioning plan shall demonstrate the ability to recycle or safe dispose all parts of the BESS. The plant/ system/ sub-system disposal has to be carried out by the bidder as per the procedure approved by the Employer during O&M period. Bidder shall comply the E-waste (management) rules-2016 Ministry of Environment, Forest and Climate Change for disposal of BESS equipments.
5.0	**Insurance** (a) NTPC shall take Fire & Allied Peril insurance during O&M period. Insurance for theft to be taken by contractor. (b) **Workmen's Compensation Insurance** This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than the following: Workmen's Compensation - As per Statutory Provisions Employee's Liability - As per Statutory Provisions (c) **Comprehensive Automobile Insurance** This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated: Fatal Injury : Rs.100,000 each person : Rs.200,000 each occurrence Property Damage : Rs.100,000 each occurrence

CLAUSE NO	TECHNICAL SPECIFICATIONS
	(d) Comprehensive General Liability Insurance The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC). The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.
6.0	**LD for shortfall in Generation during O&M** As per the provision of the bid document, the successful bidder also needs to do Operation & Maintenance of the plant for a period of 25 years from the date of completion of trial run 2.1.1 During O&M period, bidder shall be responsible for following activities but not limited to following. 2.1.2 Maintaining availability of the BESS plant 2.1.3 Carry out preventive maintenance as per OEM practices 2.1.4 Carry out breakdown maintenance. 2.2 During O&M period following parameters shall be tested every year 2.2.1 Outage duration 2.2.2 Fall in Mega Watt Hour(MWH) Capacity from declared 2.2.3 Efficiency of BESS system. 2.3 The loss in revenue due to above components shall be evaluated as follow 2.3.1 Plant outage: For deterring availability factor is to be determined Plant Availability Factor $(PAF) = \left(1-\frac{\sum Unavailable\ Duration\ Hours \times Corresponding\ MW\ Capacity \times Wt}{3.2 \times 8760}\right)100$

Wt is the Time slot weightage and depends on the instant of the outage as per following,

Time Slot	Weightage
00:00 Hrs to 06:00 Hrs	0
6:00 Hrs to 8:30 Hrs	0.2
8:30 Hrs to 10:30 Hrs	0.5
10:30 Hrs to 00:00Hrs	1.0
Time duration for which BESS availability is not required (i.e. during outage of grid, solar PV plant or due to any other reason).	0

If yearly Plant availability factor is less than 99%, contractor is liable for LD as follow

LD_{av} = (99-PAF)/100×10×0.8×3200×365 in INR

In case, there more than one equipment in the same branch is out at the same time, then the equipment having higher weightage shall be taken.

2.3.2 LD due to fall of MWH Capacity at PCC:-

LD due to fall in MWH capacity from declared capacity
= (Declared kWH-Measured kWH) ×10×0.8×365 in INR

2.3.3 Efficiency of BESS system:-

Efficiency shall calculated at the end of the year based on total measured cumulative incoming and outgoing energy of BESS system at PCC during entire one year period. Total incoming and outgoing energy for BESS system shall be recorded on daily basis based on reading in TEM energy meter located at solar PV plant 33kV switchgear end.

In case measured efficiency of BESS $\eta_{meas}\%$ is less than declared efficiency $\eta_{decl}\%$ during one year time period, the bidder is liable to pay LD due to fall of efficiency and the LD shall be calculated as follow,

$LD_{\eta Loss} = G_{Loss} \times R$ in INR

Where ***R*** is the applicable tariff (Rs 10.00)

Where $G_{Loss} = Gout \times (\frac{1}{\eta_{meas}} - \frac{1}{\eta_{decl}}) \times 100$ kWh and

$$\eta_{meas}\% = (\frac{G_{out}}{G_{in}}) \times 100$$

Where G_{in} and G_{out} are the total measured cumulative incoming and outgoing energy during entire one year period.

All applicable LD shall be first adjusted from the O &M contract value limited up to 10%. In case LD amount exceeds balance amount then it shall be adjusted from the security against **Equipment Performance Bank Guarantee** limited to 3%. In case applicable LD

is limited upto 10% O&M contract value, then 3% of the EPBG shall be returned to the bidder.

7.0 **EQUIPMENT PERFORMANCE BANK GURRANTTY/ PERFORMANCE SECURITY FOR THE BESS SYSTEM**

As per the tendering philosophy, the bidder shall quote project cost under following two major head.

a) Initial System Cost which consists first time supply of equipments, transportation, installation and commissioning including civil works for the BESS plant.

b) Year-wise investment cost which includes O&M, replacement and disposal cost for complete 25 years life of plant.

In order to ascertain the consistent performance throughout plant life, it is proposed to take Equipment Performance Bank Guarantee (**EPBG**) amounting to 10% of the total contract price quoted by Bidder for complete period of 25 years.

EPBG Operating Methodology

I. 10% of the EPBG value shall be returned after successful completion of PG Test.

II. 3% of EPBG per annum shall be returned on annual basis after successful O&M performance at the end of each year (amounting to 75%)

Last 15% of EPBG shall be returned at the end of the plant life (25 years), after successful disposal of Battery.

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E-4 PERFORMANCE GUARANTEE (PG) TEST

1.0 The final acceptance test as to prove the Performance Guarantee shall be conducted at Site by the Contractor in presence of the Employer. The PG test shall be conducted on the basis of PG test procedure to be submitted by the contractor and approved by owner.

2.0 As per the provision of technical specification, the contractor has to conduct performance guarantee test which shall consist of the following

a) Efficiency Test of BESS:

Efficiency test of BESS system shall be conducted for a period of 15 days as per procedure approved during detail engineering. Incoming and outgoing energy at point of interconnection shall be measured with ABT meters. The efficiency shall be measured as follow

$\eta_{BESS\ \%} = (G_{out} / G_{in}) \times 100$

Where G_{in} and G_{out} are the incoming and outgoing energy measured during test period.

In case measured efficiency of BESS $\eta_{meas}\%$ is less than declared efficiency

$\eta_{decl}\%$ during PG test, bidder is liable to pay LD for loss in generation on account of fall in efficiency which shall be calculated as follow

$$G_{Loss} = MWHC \times 1000 \times 365 \times BUF\left(\frac{1}{\eta_{meas}} - \frac{1}{\eta_{decl}}\right) \times 100 \quad \text{KWh}$$

MWHC is the MWH Capacity of the BESS system. It shall be 3.2 MWH for Chidiyatapu project.

BUF is the battery utilization factor and is taken as 0.8.

Applicable LD in due to efficiency $LD_{\eta loss}$ be

$LD_{\eta Loss} = G_{Loss} \times R$ in INR

Where ***R*** is the applicable tariff which is taken INR 10.0 / kWh.

$LD_{\eta Loss}$ shall be for one year as the efficiency measurement shall be done each year during operation and maintenance.

b) MWHr Capacity (**MWHC**) Testing: In order to demonstrate the required MWHC of BESS at the point of interconnection to the grid, this test shall be conducted as per mutually discussed procedure.

This test shall be conducted on an anticipated shiny & cloudless day.

In case measured MWHC is lower than the required value, bidder to install additional battery bank or take necessary corrective action to make the required MWHC. In that case MWH Capacity as well as Efficiency test shall be repeated.

E-5 SAFETY MANAGEMENT

1) Bidder shall submit the Safety Plan and the Safety Coordination Procedure as per the requirement of Attachment No: 18 Section-VII of the bidding documents.
2) During the execution of the contract, the bidder and it's sub vendor(if any) shall follow safety procedures for the safety of the personnel and the equipments during erection, testing, commissioning, operation and the maintenance during the contract period as per the regulatory requirements and as per original equipment manufacturer's recommendations
3) All the expenses, charges towards compliance of the safety norms by the bidder as per the Safety Plan, Safety Policy, and the Safety Coordination Procedures are deemed to be included in the bid price. No additional claims shall be entertained towards meeting the safety requirements.

PART-F QUALITY ASSURANCE

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F-1 QUALITY ASSURANCE CHAPTER

1) PCS
2) DC system
3) Power Supply for C&I system
4) Control desk, PLC, Fire Alarm
5) Control Cables

PART-G
GENERAL TECHNICAL REQUIREMENTS

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1.00.00	INTRODUCTION This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical requirements brought out in the Technical Specifications and the Technical Data Sheets.
2.00.00	**BRAND NAME** Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.
3.00.00	**BASE OFFER & ALTERNATE PROPOSALS** The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognized that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice may also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer along with the bid to enable the Employer to determine the acceptability of these proposals.
4.00.00	**COMPLETENESS OF FACILITIES**
4.01.00	Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure that a completely engineered plant is provided.
4.02.00	All equipment furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation & maintenance of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not

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	have been specifically detailed in the respective specifications, unless included in the list of exclusions. All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.
5.00.00	**CODES & STANDARDS**
5.01.00	In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India as well as of the locality where they will be installed, including the following**:** (a) Bureau of Indian Standards (BIS) (b) Indian electricity act (c) Indian electricity rules (d) Indian Explosives Act (e) Indian Factories Act and State Factories Act (f) Indian Boiler Regulations (IBR) (g) Regulations of the Central Pollution Control Board, India (h) Regulations of the Ministry of Environment & Forest (MoEF),Government of India (i) Pollution Control Regulations of Department of Environment, Government of India (j) State Pollution Control Board. (k) Rules for Electrical installation by Tariff Advisory Committee (TAC). (l) Any other statutory codes / standards / regulations, as may be applicable.
5.02.00	Unless covered otherwise by Indian codes & standards and in case nothing to the contrary is specifically mentioned elsewhere in the specifications, the latest editions

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	(as applicable as on date of bid opening), of the codes and standards given below shall also apply: (a) Japanese Industrial Standards (JIS) (b) American National Standards Institute (ANSI) (c) American Society of Testing and Materials (ASTM) (d) American Society of Mechanical Engineers (ASME) (e) American Petroleum Institute (API) (f) Standards of the Hydraulic Institute, U.S.A. (g) International Organization for Standardization (ISO) (h) Tubular Exchanger Manufacturer's Association (TEMA) (i) American Welding Society (AWS) (j) National Electrical Manufacturers Association (NEMA) (k) National Fire Protection Association (NFPA) (l) International Electro-Technical Commission (IEC) (m)Expansion Joint Manufacturers Association (EJMA) (n) Heat Exchange Institute (HEI)
5.03.00	Other International/ National standards such as DIN, VDI, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, alongwith the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.
5.04.00	As regards highly standardized equipment National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by

	these National / International standards, established and proven standards of manufacturers shall also be considered.
5.05.00	In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.
5.06.00	Two (2) English language copies of all-national and international codes and/or standards which are not available with BHEL/NTPC and same is used in the design of the plant, equipment, civil and structural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.
5.07.00	In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.
6.00.00	**EQUIPMENT FUNCTIONAL GUARANTEE**
6.01.00	The functional guarantees of the equipment under the scope of the Contract is given elsewhere in the technical specification. These guarantees shall supplement the general functional guarantee provisions covered under General Conditions of Contract.
6.02.00	Liquidated damages for shortfall in meeting functional guarantee(s) during the performance guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.
7.00.00	**DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**
7.01.00	**Design of Facilities** All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere. The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the

	natural frequency of the complete unit is not critical or close to the operating range of the unit.
7.02.00	Maintenance and Availability Considerations
	Equipment/facilities offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.
7.03.00	Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely the minor and major overhauls shall be specified in terms of fired hours, clearly defining the spare parts and man-hour requirement for each stage.
	Lifting devices i.e. hoists and chain pulley jacks, etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 kgs during erection and maintenance activities.
	Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.
8.00.00	**DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**
8.01.00	Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.
8.02.00	The Contractor shall furnish engineering data/drgs. for entire equipment covered under this specification in accordance with the schedule of information as specified in Technical Specification and Data sheets.. This documentation shall include but not be limited to the following :
8.02.01	**INSTRUCTION MANUALS**
	The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Employer the Instruction Manuals shall be submitted. The Contract shall not be considered to be

completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

(a) Erection & Commissioning Manuals/Checklists

The erection & Commissioning Manuals/Checklists shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipment like cranes, dozers, etc. f) Bill of Materials

g) Procedure for erection.

h) General safety procedures to be followed during erection / installation.

i) Procedure for initial checking after erection.

j) Procedure for testing and acceptance norms.

k) Procedure / Check list for pre-commissioning activities.

l) Procedure / Check list for commissioning of the system.

m) Safety precautions to be followed in electrical supply distribution during erection

(b) Operation & Maintenance Manuals

i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, maintain, dismantle,

reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.

ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Employer for records.

iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

iv. The manuals shall include the following :

a. List of spare parts along with their drawing and catalogues and procedure for ordering spares.

b. Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

c. Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.

v. Detailed specifications for all the consumables including lubricant oils, greases, and chemicals etc. system/equipment/assembly/sub D assembly - wise required for the complete plant. vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Employer indicating lubrication method for each type/category of bearing.

8.02.02 **Project Completion Report**

The Contractor shall submit a Project Completion Report at the time of handing over the plant. After final acceptance of individual equipment

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	/system by the Employer, the Contractor will update all original drawings and documents for the equipment/ system to "as built" conditions and submit.
8.03.00	**ENGINEERING INFORMATION SUBMISSION SCHEDULE** Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorised into the following parts. a) Information that shall be submitted for the approval of the Employer before proceeding further, and b) Information that would be submitted for Employer's information only. The Engineering Information Schedule shall be updated month-wise. The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.
8.04.00	**ENGINEERING PROGRESS AND EXCEPTION REPORT** Report giving the status of each engineering information including (a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission (b) Drawings which were not submitted as per agreed schedule. The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.
8.05.00	**TECHNICAL CO-ORDINATION MEETING** • The Contractor shall organize and attend at least one monthly progress Meetings with the Employer/Employer's representatives during the period of Contract at mutually agreed venues for review of progress & resolving technical clarifications, if any. The Contractor

shall attend such meetings at his own cost and fully co-operate with such persons and agencies involved during the discussions.

- The Contractor shall ensure availability of theconcerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that, if required, the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.
- The Contractor shall furnish monthly progress report to the Employer detailing out the progress achieved on all erection activities as compared to the schedules. This shall be supplemented by printed colour photographs and video in VCD/DVD indicating various stages of erection and the progress of the work done at Site. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.

8.06.00 **DESIGN IMPROVEMENTS**

The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

8.07.00 **EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate which support the unit and its drive assembly, shall be of a neat design with pads for anchoring

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	the units, shall have a raised lip all around, and shall have threaded drain connections.
8.08.00	**PROTECTIVE GUARDS**
	Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.
8.09.00	**LUBRICANTS, SERVO FLUIDS AND CHEMICALS**
	The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder.
8.09.01	As far as possible lubricants marketed by reputed companies shall be used. The variety of lubricants shall be kept to a minimum possible.
	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer alongwith lubrication requirements.
8.09.02	Lubrication
	Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.
8.10.00	**Material of Construction**
	All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.
8.11.00	**RATING PLATES, NAME PLATES & LABELS**
8.11.01	Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of noncorrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.
8.11.02	Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering

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	engraved on the back. The name plates shall be suitably fixed on both front and rear sides.
8.11.03	Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.
8.11.04	Nameplates shall be as per best practices of the industry
8.11.05	All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.
8.11.06	All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system
8.12.00	**TOOLS AND TACKLES** The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer. The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Employer.
8.13.00	**Welding** If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be per formed by

others the requirements shall be submitted to the Employer in advance of commencement of erection work.

8.14.00 **COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.

8.15.00 **PROTECTION AND PRESERVATIVE SHOP COATING**

8.16.00 **PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.

8.17.00 **Preservative Shop Coating**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer.

Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.

Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be

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	used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer. All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Employer. All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled. Painting for Civil structures shall be done as per relevant part of technical specification
9.00.00	**QUALITY ASSURANCE PROGRAMME** a) The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001.A quality assurance programme of the contractor shall generally cover the following: b) (a) His organisation structure for the management and implementation of the proposed quality assurance programme (b) Quality System Manual (c) Design Control System (d) Documentation and Data Control System (e) Qualification data for bidder's key personnel. (f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis,

source inspection, incoming raw-material inspection, verification of materials purchased etc.

(g) System for shop manufacturing and site erection controls including process, fabrication and assembly.

(h) Control of non-conforming items and system for corrective actions and resolution of deviations.

(i) Inspection and test procedure both for manufacture and field activities.

(j) Control of calibration and testing of measuring testing equipment.

(k) System for Quality Audits.

(l) System for identification and appraisal of inspection status.

(m) System for authorising release of manufactured product to the Employer.

(n) System for handling, storage and delivery.

(o) System for maintenance of records, and

(p) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

c) GENERAL REQUIREMENTS - QUALITY ASSURANCE

a) All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-01/F3.

b) Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein

and quality practices and procedures followed by Contractor's/ Subcontractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

c) Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.

d) The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

e) No material shall be dispatched from the manufacturer's works before the same is accepted, subsequent to predispatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for dispatch by issuance of Material Despatch Clearance Certificate (MDCC).

f) All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests

shall be carried out as per applicable material standards and/or agreed details.

g) The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-CQAW-11/F1. The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.

h) All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.

All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.

i) All brazers, welders and welding operators employed on any part of the contract either in Contractor's / sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.

j) Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

k) For all pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.

l) Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

m) No welding shall be carried out on cast iron components for repair.

n) All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

o) All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American

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	Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested. p) The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from subcontractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of preawards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract. q) For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor

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	along with a report of the Purchase Order placed so far for the contract. **
	r) Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.
	s) The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.
	t) Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
	u) For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
	v) Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.
	w) **Environmental Stress Screening**
	All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following
	1) The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed.

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	The necessary details as required under this clause shall be furnished at the stage of QP finalization. or In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure. 2) Elevated Temperature Test Cycle During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service. During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C. **<u>Burn in Test Cycle</u>** The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test. The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time. During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems; the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable. During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

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	x) The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the subcontractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalized with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The sub-vendors name which are not in BHEL/NTPC provided list shall be deemed to be considered in DR category. Standard Manufacturing Quality Plan (SQP)/Indicative Manufacturing Quality Plan(IQP)/ Standard Field Quality Plan (SFQP)/ Indicative Field Quality Plan(IFQP) are enclosed for the major items, which can be used as a reference purpose for item under consideration. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors and shall be submitted to the Employer for approval within a time bound schedule drawn during detailed engineering process. Such sub-vendor proposed in his bid offer shall be deemed to be identified in DR category and upon final acceptance by BHEL/NTPC in writing, contractor can place order on such accepted sub-vendor only. Monthly progress reports on sub-contractor detail submission / approval shall be furnished as per Engineering Co-ordination Procedure. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract. Sub-vendor whose details are not submitted within the agreed cut-off date, shall be deemed to be withdrawn by the contractor.

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	d) QA DOCUMENTATION PACKAGE The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick mark. y) Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document. The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing. The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks. z) Typical contents of QA Documentation is as below:- (a) Quality Plan (b) Material mill test reports on components as specified by the specification and approved Quality Plans. (c) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans. (d) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment. (e) Heat Treatment Certificate/Record (Time- temperature Chart) (f) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure). (g) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points. (h) Certificate of Conformance (COC) wherever applicable. (i) MDCC

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	aa) Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system. bb) Before dispatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review. (a) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release. (b) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector. If a decision is made dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time. The supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

cc) TRANSMISSION OF QA DOCUMENTATION

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

e) Project Manager's Supervision

To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC of Vol.I, the Contractor shall proceed to comply with the Project Manager's decision.

dd) The work shall be performed under the supervision of the Project Manager. The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

(a) Interpretation of all the terms and conditions of these documents and specifications:

(b) Review and interpretation of all the Contractor's drawing, engineering data, etc:

(c) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

(d) Inspect, accept or reject any equipment, material and work under the contract :

(e) Issue certificate of acceptance and/or progressive payment and final payment certificates

(f) Review and suggest modifications and improvement in completion schedules from time to time, and

(g) Supervise Quality Assurance Programme implementation at all stages of the works.

f) INSPECTION, TESTING AND INSPECTION CERTIFICATES

ee) The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency

acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

ff) The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

gg) The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

hh) The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

ii) When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not

bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

jj) In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

kk) The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

ll) To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

mm) All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by BHEL/NTPC. Wherever asked specifically, the contractor shall re-

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	calibrate the measuring/test equipment in the presence of Project Manager / Inspector **g) ASSOCIATED DOCUMENT FOR QUALITY ASSURANCE PROGRAMME:** nn) List of items requiring quality plan and sub supplier approval. Format No.:QS-01-QAI-P-01/F3-R0. oo) Manufacturing Quality Plan Format No.: QS-01-QAI-P-09/F1-R1 pp) Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1.
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10.00.00	**PRE-COMMISSIONING AND COMMISSIONING FACILITIES** The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities. All precommissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor's quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor. The pre-commissioning and commissioning activities of the equipment/systems furnished and installed by the contractor shall be the responsibility of the Contractor. The Contractor shall provide, in addition, temporary instrumentation and other measuring devices, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.
10.01.00	**All erection & commissioning checks shall be as per manufacturer's manual on mutually agreed terms** (a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning

tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.

(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(c) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(d) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over for commissioning (start-up), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SCL (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] to be furnished by the manufacturer/supplier.

(e) The Contractor shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

11.00.00 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

(a) Working platforms should be fenced and shall have means of access.

(b) Ladders in accordance with Employer’s safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

12.00.00 **PACKAGING AND TRANSPORTATION**

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in

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	India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Employer's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.
13.00.00	**ELECTRICAL ENCLOSURE**
	All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specification.
14.00.00	**INSTRUMENTATION AND CONTROL**
	All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.
i)	All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.
	All scales and charts shall be calibrated and printed in Metric Units
j)	All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.
k)	All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better
15.00.00	**ELECTRICAL NOISE CONTROL**
	The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor’s equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-801- 2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems.
16.00.00	**ELECTRONIC MODULE/COMPONENT DETAILS**
	The Bidder shall have to furnish all technical details including circuit diagrams, specifications of components, etc., in respect of each and every

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	electronic card/module as employed on the various solid state as well as microprocessor based systems and equipment including conventional instruments, peripherals etc. It is mandatory for the Bidder to identify clearly the custom built ICs used in the package. The Bidder shall also furnish the details of any equivalents of the same.

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PART-I
MANDATORY SPARES

Mandatory Spares:-

The Bidder shall include in his scope of supply following spares (as applicable) as described below. The specification of these spares shall be as per relevant chapter. These minimum specified spares shall be in custody of the contractor in healthy condition during complete O&M period. Contractor shall use these spares, replenish the spare(s) of the matching quality, quantity and rating within shortest possible time.

S.No	Description	Unit	Quantity*
1.	Electronic Cards for PCS	5% of total population for each type	
2.	IGBT Unit for PCS	5% of total population for each type	
3.	Semiconductor Fuse for PCS	5% of total population for each type	
4.	PCS Contactor, cooling fan, SPD, Aux transformer, current sensor, current transformer, Power fuse, semiconductor fuse, control fuse, AC filter chock & capacitor, DC capacitor, SMPS (power supply unit), MCB	5% of total population for each type	
5.	AC Fuse of all type	5% of total population for each type	
6.	Ethernet switch	5% of total population for each type	
7.	DC Cable of highest size	KM	1

NOTE:- (i) Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by the bidder shall be the specified percentage (%) of the total population required to meet the specification requirements. In case the quantity of spares so calculated happen to be a fraction, the same shall be rounded off to next higher whole number.

(ii) Interchangeability and Packing: All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended replacements.

(iii) Identification : Each spare shall be clearly marked and labeled on the outside of the packing with its description when more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

The general requirements pertaining to the supply of mandatory spares is as under.

(a) The bidder shall indicate the prices for each and every item (except for items not applicable to the bidders design) in the 'Schedule of mandatory Spares' whether or not he considers it necessary for the Owner to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in the Bid

Forms and Price Schedules. Whenever the quantity is mentioned in “sets” the bidder has to give the item details and prices of each item.

(b.) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number.

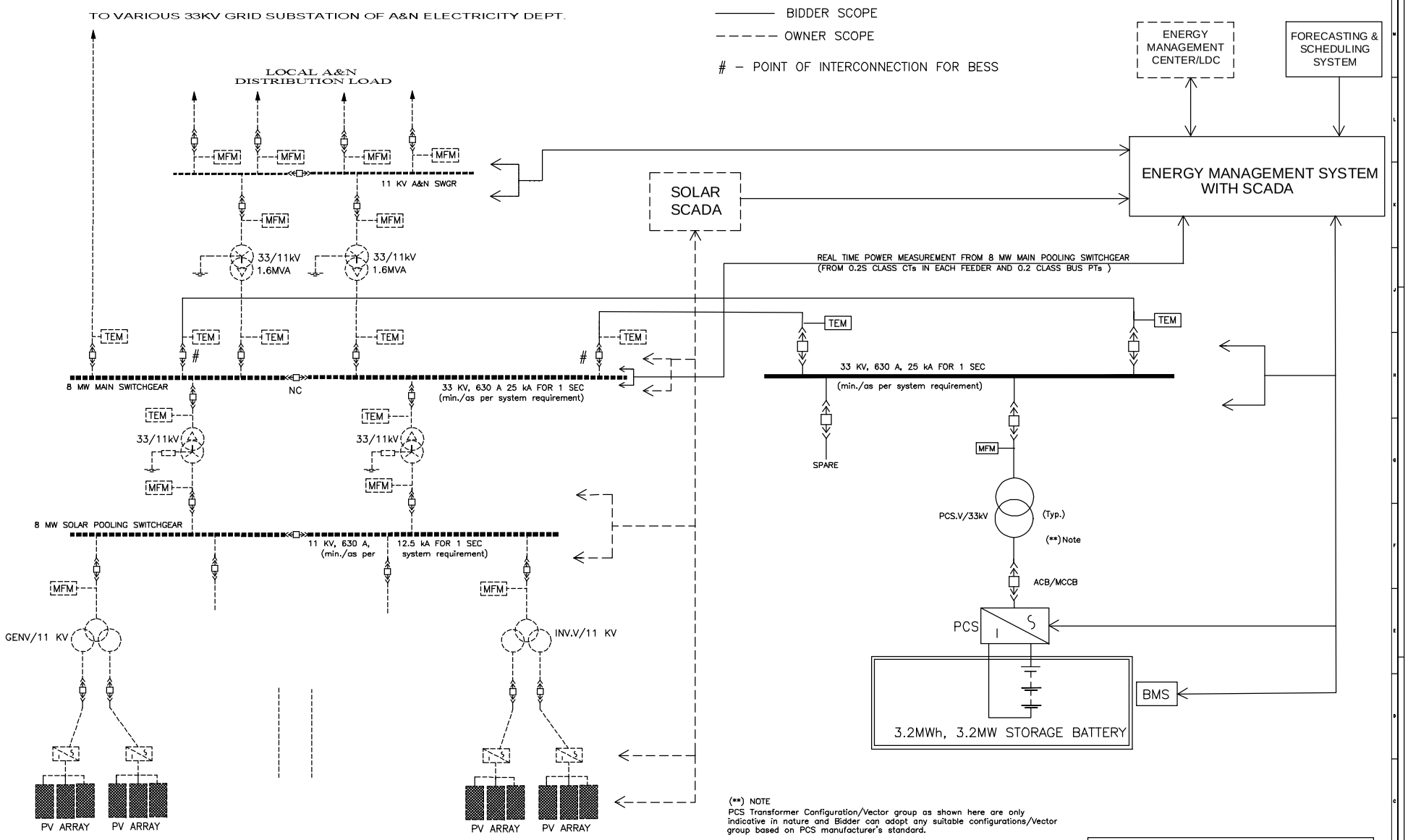
(c) Wherever the requirement has been specified as a ‘set’ it will include the total requirement of the item for a unit, module or the station or as specified. Where it is not specified a ‘set’ it will include the total requirement of the item for a unit, module or the station or an as specified. Where it is not specified a ‘set’ would mean the requirement for the single equipment/system as the case may be. Also one set for the particular equipment. e.g. ‘set’ of bearings for a pump would include the total number of bearings in a pump. Also the ‘set’ would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.

(d.) The Owner reserves the right to buy any or all the mandatory spares parts.

(e.) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.

(f.) All mandatory spares shall be delivered at site at least two months before scheduled commissioning of the BESS plant. However, spares shall not be dispatched before dispatch of corresponding main equipments.

(g.) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.



FOR TENDER PURPOSE ONLY

NOTES

1.) ALL NECESSARY HARDWARES FOR INTERFACING WITH PV PLANT FOR BESS SYSTEM TO BE FULLY FUNCTIONAL AS PER SPECIFICATION SHALL BE UNDER BIDDER'S SCOPE.

2.) INSTANTANEOUS SOLAR PLANT GENERATION, GRID POWER AND LOCAL LOAD POWER FOR BESS USE ARE TO BE TAKEN FROM 0.2S CLASS FEEDER CTs AND 0.2 CLASS BUS PT OF 8 MW MAIN SWITCHGEAR. NECESSARY WIRING AND OTHER HARDWARE FROM 8 MW MAIN SWGR PANEL TO BESS CONTROL ROOM WILL BE UNDER BIDDER'S SCOPE.

FOR TENDER PURPOSE ONLY									
DESCRIPTION	DRAWN	DESIGN	CHKD.	APPD	DATE	SIZE	SCALE	DRG. NO.	REV. NO.
						A3	NTS	5727-004(B)-POE-A-001	01

OWNER: NTPC Limited (ENGINEERING DIVISION, A GOVERNMENT OF INDIA ENTERPRISE)

PROJECT: BATTERY ENERGY STORAGE SYSTEM FOR 8MW SOLAR PV PROJECT AT CHIDIYATAPU IN SOUTH ANDAMAN, A&N ISLANDS

TITLE: BASIC SCHEMATIC DIAGRAM