



BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

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	CONSULTANT	Desein Private Limited, New Delhi																																							
	PROJECT	400kV GIS at 2x660MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS																																							
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<u>Contents</u> <table border="1"><thead><tr><th>Section No.</th><th>Description</th><th>No of Pages</th></tr></thead><tbody><tr><td>0</td><td>Cover Sheet</td><td>1</td></tr><tr><td>1</td><td>Scope, Bill of Quantities & Project specific technical requirements</td><td>8</td></tr><tr><td></td><td>Annexure BOQ</td><td>1</td></tr><tr><td>2</td><td>Specific technical requirements for the equipment under scope of supplies</td><td>10</td></tr><tr><td></td><td>Vol-IV Electrical works – DC System</td><td>22</td></tr><tr><td>3</td><td>Project details and general technical requirements for all equipment under the Project.</td><td>44</td></tr><tr><td>4</td><td>Annexures</td><td></td></tr><tr><td>Annexure-A</td><td>Schedule of Technical Deviations</td><td>1</td></tr><tr><td>Annexure-B</td><td>Compliance Certificate</td><td>1</td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></tbody></table> Remarks: Bidder to note that data and details of Guaranteed Technical Particulars shall not be reviewed during Technical Review, hence compliance of Technical Specification shall be bidder's responsibility.						Section No.	Description	No of Pages	0	Cover Sheet	1	1	Scope, Bill of Quantities & Project specific technical requirements	8		Annexure BOQ	1	2	Specific technical requirements for the equipment under scope of supplies	10		Vol-IV Electrical works – DC System	22	3	Project details and general technical requirements for all equipment under the Project.	44	4	Annexures		Annexure-A	Schedule of Technical Deviations	1	Annexure-B	Compliance Certificate	1						
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4	Annexures																																								
Annexure-A	Schedule of Technical Deviations	1																																							
Annexure-B	Compliance Certificate	1																																							
Rev	Date	Altered	Checked	Approved																																					
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Section 1: Scope, Technical Requirements and Quantities

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to project site and supervision of erection, testing & commissioning of **220V, 150A & 48V, 100A Float cum Boost Charger, accessories & Discharge Load Bank** complete in all respect for efficient & trouble free operation mentioned under this specification.

This section covers the specific technical requirements of **220V, 150A & 48V, 100A Float cum Boost Charger & Accessories with Discharge Load Bank**. This constitutes minimum technical parameters for the above item as specified by the customer/TANGEDCO. The offered equipment/ item shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) of this specification.

The specification comprises of following sections,

- Section-1 : Scope, Project specific technical requirements & Bill of Quantities.
- Section-2 : Specific technical requirements for the equipment under scope of supplies.
- Section-3 : Project Details and General technical requirements for all equipment under the Project.
- Section-4 : Annexures (04nos.)

In case of any discrepancies between the requirements mentioned under different Sections, order of precedence shall be Section-1, Section-2, Section-3.

No deviation from the requirements specified in various clauses of this specification shall be allowed. A certificate to this effect shall have to be furnished along with the offer.

The equipment is required for the following project:

Name of the : Tamilnadu Generation and Distribution Corporation
Customer (TANGEDCO)
Name of consultant : Desein Private Limited, New Delhi

Name of the Project : 400kV GIS at 2x660MW Ennore SEZ Supercritical Thermal
Power Project at Ash Dyke of NCTPS

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

Specific technical requirements shall be as follows,

Sl. No.	Parameter	220V, 150A Battery Charger	48V, 100A Battery Charger
1.	Battery Charger type	SMPS based modular type combined float cum boost	SMPS based modular type combined float cum boost
2.	Nominal voltage rating	220V	48V
3.	Rated current rating	150A	100A
4.	Degree of protection	IP42	IP42
5.	DC voltage setting adjustment of AVR for float charging	±10% of nominal voltage	±10% of nominal voltage
6.	Voltage stabilization for constant voltage regulator	i) ±1% of set DC voltage for ±10% voltage & +3% to -5% frequency variation in power supply ii) ±5% during transients	i) ±1% of set DC voltage for ±10% voltage & +3% to -5% frequency variation in power supply ii) ±5% during transients
7.	DC current adjustment for boost charging	30% to 100% of maximum boost charging current	30% to 100% of maximum boost charging current
8.	Current stabilization for constant current regulator for boost charger	±2%	±2%
9.	Minimum permissible pf at rated continuous load	0.8	0.8
10.	Permissible ripple content at rated continuous load	1% maximum	1% maximum
11.	Short circuit level for AC	50kA for 1sec	50kA for 1sec
12.	Short circuit level for DC	25kA for 1sec	10kA for 1sec
13.	Ambient design temperature	50°C	50°C
14.	Cooling	The charger shall be natural air cooled	
15.	Load Bank / Discharge Resistor Panel	a) Portable type battery discharge resistor panels shall be supplied with shunt suitable for 10 hrs. Discharge rate (C10 rate) as per battery capacities indicated in the BOQ cum price schedule. b) Discharge resistor shall be fan cooled. 2x100% fans shall be provided. c) Construction shall be same as Charger panel. Handle and wheel arrangement shall be	

Sl. No.	Parameter	220V, 150A Battery Charger	48V, 100A Battery Charger
		provided for easy movement. d) Control - Using rotary switches for step control of current against falling voltage with ON-OFF facility. e) IP -32 and above	
16	Battery data		
	i) Battery type	Ni- Cd Fibre Plate type	Ni- Cd Fibre Plate type
	ii) Nominal voltage rating	220V	48V
	iii) Discharge capacity	600AH (5Hrs)	400AH (5Hrs)
	iv) Float charging voltage	1.40V to 1.42V	1.40V to 1.42V
	v) Boost charging voltage	1.54V to 1.70V	1.54V to 1.70V
	vi) End cell voltage	Not less than 1.14V	Not less than 1.14V
	vii) Nominal cell voltage	1.20V/cell	1.20V/cell
	viii) Maximum battery bank voltage	242V	52.80V
	ix) Minimum battery bank voltage	198V	43.20V
	x) No. of cells per battery	170 nos.	38 nos.

Note:

1. Suitable & necessary interlock shall be provided to avoid accidental boost mode operation when loads are connected to the bus.
2. For detailed technical requirement Float cum Boost Charger & Accessories with Discharge Load Bank please refer Section-2.
3. Panels shall be manufactured from cold rolled sheet steel of minimum 2 mm thickness with doors and base frame of minimum 2.5 mm thick cold rolled sheet

1.2.1 Charger shall have following features:

1. Pulse width modulation
2. High frequency DC/AC converting
3. Voltage stabilization tolerance: $\leq \pm 0.5\%$
4. Current stabilization tolerance: $\leq \pm 0.5\%$
5. Ripple coefficient: $\leq 1\%$ (irrespective of DC load, even when not connected to battery)
6. Power factor: ≥ 0.92
7. Efficiency: $\geq 92\%$
8. Standby mode: N+2 module online
9. MTBF: $\geq 100,000$ h
10. Remote control functions
11. Modular Design

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12. LCD Control Display Panel
 13. Multi-Point Monitoring
 14. Remote Communication
 15. Software Programmable
 16. AC Ripple < 1%
 17. Dynamic Response < 100 micro. sec.
 18. THD < 5%
 19. Enhanced earth fault monitoring (can be achieved through controller)
 20. Tunable Output
 21. Intelligent float boost & equalize charging
 22. Temperature compensated charging for VRLA
 23. Total control on each charging module
 24. Storing historic alarms
 25. Remote communication with RS 232 & 485

1.2.2 ANNUNCIATION SYSTEM

Multifunctional LCD display module shall be provided which shall serve both the purpose of metering as well as annunciations. Following minimum annunciations shall be provided:

1. AC supply failure
2. AC input fuse failure/MCCB trip (separate for each charger)
3. AC Undervoltage/Overvoltage
4. DC output MCCB failure, positive grounded, negative grounded
5. Charger failure
6. Surge arrestor operated
7. Load overload
8. Charger trip/over loaded
9. Battery on boost
10. DC system earth fault
11. Battery fuse blown
12. DC system under voltage/over voltage
13. Module failure
14. Battery on float
15. Load limiter operated

Initial contacts for alarm points shall have electrically separate spare set of contacts wired up to the terminal block for future use.

Following minimum indications via LED shall be provided on each charger:

1. DC supply healthy
2. Control supply ON
3. Charger power supply ON
4. Charger DC output healthy

-
5. Float charger ON
 6. Float charger Fail
 7. Boost charger in operation
 8. Float cum boost charger in boost mode
 9. Float cum boost charger in float mode
 10. SMPS Module failed

Following initiating contacts shall be provided for remote alarm for each of the float and boost chargers. The alarms shall be provided for the SAS / SCADA Panel.

1. Main AC failure
2. Main AC input under voltage
3. Charger AC input fuse blown
4. Charger DC output fuse blown
5. Charger U/V and current limit protection
6. Charger Over voltage protection
7. Charger Over current protection
8. Charger Filter condenser fuse blown
9. Charger Rectifier fuse blown
10. Tap Contactor off
11. DC Voltage
12. Charger Current & Voltage
13. DC System positive grounded
14. DC System negative grounded
15. Battery on Boost
16. Battery on Float
17. SMPS Module failed
18. Charger Fail / Trip

Following annunciation features shall be available in the charger (can be achieved through controller):

1. The arrangement shall be such that on occurrence of a fault the corresponding window will light up and stay lighted until the fault is cleared and reset button is pressed.
2. Each time a window lights up, a master relay will get energized to provide group alarm signals for owners remote panel.

1.3 BILL OF QUANTITIES

Please refer **Annexure_BOQ** for the quantities for supply and services

Note:

1. Size of cable between battery & battery charger and battery charger & DCDB shall be informed during detailed engineering for fixing of terminal block of appropriate size. Minimum size 2X2X150 Sqmm Cu cable for 220V DC & 2X2X150 Sqmm Cu for 48V DC. 415V AC incomer cable for 220V Charger should be suitable to

terminate 3.5CX70 Sqmm Al & 48V – 3.5CX35/70 Sqmm Al.

2. Additional terminal block for battery charger & DCDB connection and battery charger & battery connection shall be provided.
3. The battery chargers under (Sl.no.1&2) shall be evaluated together and will be procured from the same bidder.
4. The quantity for individual item may vary up to any extent, however total contract value may vary by +/- 30% during contract execution stage. It is also to be noted that any item can be completely/ partially deleted during detailed engineering stage.

1.4 TECHNICAL QUALIFYING REQUIREMENT & EXPERIENCE

Refer **Annexure-** (1.) PQR_48V: applicable for 48V Battery Charger
(2.) PQR_220V: applicable for 220V Battery Charger

1.5 TYPE TESTING

The bidder shall submit the type tests reports for the tests conducted on the equipment similar to those to be supplied under this contract and the test(s) should have been conducted at an independent laboratory not earlier than five (5) years prior to date of supply.

In case the bidder is not able to submit valid report of the type test(s) or in case type test report(s) are not found to be meeting the specification requirements, or not including all specified tests the bidder shall conduct all such tests. The cost of such test shall be borne by the bidder without cost and delivery implication to BHEL. The BHEL/owner shall have right to witness the type tests. Waiver of type tests will not be entertained in normal circumstances.

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.

1.6 QUALITY PLAN

The successful bidder shall submit the QP for BHEL/ TANGEDCO approval. In case bidder has reference QP agreed with TANGEDCO, same can be submitted for specific project after award of contract for BHEL/ TANGEDCO's approval. There shall be no commercial implication to BHEL on account of QP approval.

All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all these tests for all the equipment & components shall be deemed to be included in the bid price.

1.7 INSPECTION & TESTING

Before being fitted on the equipment, all components shall be subjected to routine tests at the Contractors factory, provided by the relevant IEC/IS standards. A detailed test

report proving the successful passing of such tests shall be provided.

Prior to dispatch, the routine & acceptance tests shall be carried out on each item in accordance with the applicable IEC/IS and the material shall be offered for final inspection by BHEL/TANGEDCO in accordance with agreed quality plan with 3 weeks' advance information. The charges for these shall be deemed to be included in the equipment price.

1.8 PACKING

The material shall be packed in such a way to ensure protection against damage during transit, storage for minimum 1 year and handling at site.

1.9 COMMISSIONING

- 1.9.1 The bidder shall carryout the following commissioning tests and checks after installation of the equipment at site:
- a) Complete physical examination
 - b) Checking of proper operation of annunciation system
 - c) Temperature rise test at full load
 - d) Insulation resistance test
 - e) Automatic voltage regulator operation
 - f) Load limiter operation
 - g) Dynamic response test
 - h) Voltage regulation test

Overshoot/ Undershoot in output voltage of the Charger as a result of sudden change in load from 100% to 20% and 20% to 100% shall be measured with the Batteries connected/disconnected. Output voltage of the Charger connected with Battery shall be within 94% to 106% of the voltage setting in above conditions and shall return to, and remain, within the limits specified as mentioned elsewhere, in less than 2 seconds (as applicable).

1.10 DRAWINGS REQUIRED ALONG WITH TECHNICAL OFFER

- a) Unpriced Price Schedule as enclosed with NIT with "Quoted" word against items with bidder's signature and company stamp.
- b) A copy of the sheet "Compliance certificate" with bidder's signature and company stamp.
- c) "Deviation Schedule" with "NO DEVIATION" and bidder's signature and company stamp.

1.11 DRAWINGS & DOCUMENTS TO BE SUBMITTED

Following documents/drawings shall be submitted after placement of order for BHEL & customer's approval:

- a) Data Sheet for Battery Charger
- b) General Arrangement drawing for Battery Charger

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- c) Schematic/ Power Circuit diagram for Battery Charger
 - d) Circuit diagram and GA of battery fuse box
 - e) Circuit diagram and GA of battery discharge panel
 - f) Operation Write up for Battery Charger
 - g) Internal Layout drawing for Battery Charger
 - h) Field Quality plan for Battery Charger
 - i) List of Mandatory Spares for Battery Charger
 - j) Type test certificates for the Battery Charger
 - k) O&M Manual for Battery Charger
 - l) Bill of Material for Battery Charger with list of makes
 - m) Fault level Calculation for Battery Charger
 - n) AC Power consumption in float mode & boost mode
 - o) List of E & C Spares for Battery Charger
 - p) Termination Arrangement At Battery Charger Terminals
 - q) Packing list
 - r) Quality Plan for Battery Charger

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TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

1.0 INTRODUCTION

Specific technical requirements for the equipment under scope of supplies.

2.0 CODES AND STANDARDS

The equipment shall generally conform to IS. Unless otherwise specified, the latest revisions of codes/ standards specified in Section-1 enclosed are applicable.

3.0 OPERATIONAL REQUIREMENTS

3.1 Under normal conditions, when the AC supply is healthy at the battery charger input terminals, the float charger shall feed the continuous DC loads, while the boost charger shall remain off. Over and above the continuous DC loads the float charger shall also supply the necessary trickle charge to the battery, to keep the later in fully ready condition for being available during AC supply failure at charger terminals. Also some of the impulse loads of duration less than a minute for which the response of the charger is poor, shall be supplied by the associated battery in the DC system. This impulse discharge, shall, however, be continuously replenished by the float charger, unless the discharge is of considerable magnitude, in the event of which the boost charger shall be deployed.

3.2 The float charger shall withstand momentary supply failure due to changeover on AC supply feeding bus and continue to operate on float mode satisfactorily on restoration of AC supply to charger.

3.3 The 220V DC system shall be ungrounded and shall float with respect to the ground potential when healthy. An earth fault detection and annunciation feature shall be provided. 48V DC system shall be grounded on (-) polarity.

3.4 After the batteries are boost charged and operation is changed to float mode, the voltage impressed on the loads shall not exceed float charge voltage.

3.5 The charger shall be designed to operate at an ambient air temperature of 50°C. It will be located indoor with clean environment but in a hot, humid and tropical atmosphere / costal area.

4.0 BATTERY CHARGERS

4.1 The battery chargers shall be self-regulating, modular type hot-swappable based SMPS controlled, full wave fully controlled bridge configuration by micro-processor based controlling & monitoring unit.

4.2 Each charger circuit shall be provided with meters, control switches, rectifiers, Auto/ Manual voltage regulators, load limiting device, etc. as required for the successful operation of the DC system.

4.3 The charger shall have auto voltage regulators with digital voltage set value, smooth, stepless smoothening filter circuit and continuous voltage control. The chargers shall have the effective current limiting feature and SMPS module should have features to minimise harmonics, radio frequency transients, electromagnetic transients, etc. Filter circuit



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART – A)

function can be Inbuilt in the SMPS module

- 4.4 The battery chargers shall be capable of continuous operation at the respective rated load in float charging mode i.e. trickle charging the associated DC batteries while supplying the DC loads.
- 4.5 The Float/Boost mode of operation shall be selected automatically/manually through the microprocessor controller with necessary accessories like push button/switch etc.
- 4.6 The battery chargers shall be provided with automatic control of output voltage and current through microprocessor controller. The voltage & current values can be set manually through controller. Necessary input filters in individual SMPS modules shall be provided to avoid input current/voltage surges of harmful magnitude/nature, under normal operating condition & switching action at load end.
- 4.7 Soft start feature shall be inbuilt feature of SMPS modules. The chargers shall have load limiters, when the DC load current exceeds the load limiter setting of the charger a gradual lowering of the output voltage shall start to limit the load current through controller. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall not damage the charger nor SMPS modules & not any charger fuses. The charger shall not trip on overload or external short circuit. After clearance of fault, the charger voltage shall build-up automatically. Step less adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode.
- 4.8 During float charging, the charger output voltage shall remain within 1% of the set value for AC input voltage variation and a continuous DC load variation from zero to full load. The output voltage setting shall be made through controller for float as well as for boost mode for required entire output range as required/specified.
- 4.9 During boost charging, the battery chargers shall operate on constant current or constant voltage with current limit mode. The boost charging current can be adjusted through controller over a range of 50% to 100% of the rated output current for boost charging mode. The charger output voltage shall automatically go on rising, when operating in boost mode, as the battery charges up. The charger voltage limit setting can be settable from controller which shall be password protected.
- 4.10 Energising the charger with fully charged battery connected plus 10% load shall not result in output voltage greater than $\pm 110\%$ of voltage setting. The time taken to stabilise within specified limits shall be less than 10 seconds.
- 4.11 Momentary output voltage of the Charger, without the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice- versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above mentioned change.
- 4.12 Float-cum-boost SMPS charger voltage & current limit setting for Float mode & Boost mode shall be independent.
- 4.13 SMPS module shall be capable to limit the ripple content (peak to peak) in the output voltage to 1%, irrespective of the DC load fluctuation even when they are not connected to a battery.



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

- 4.14 The Charger unit shall be suitable for operation in parallel with one or more identical units that may have unsynchronized AC supplies.
- 4.15 Under normal conditions, both SMPS type charger units shall operate in parallel sharing the total DC load, and each in addition supplying the battery set with float charging current. In case of failure of either the charger units or loss of input AC supply, the other charger shall feeding the complete DC load. Faulty charger shall automatically get disconnected from the healthy system and alarm shall be initiated. When the lost AC source is restored, SMPS type charger unit shall automatically resume its normal duty mode. In case of Mains failure of both the charger battery will supply load for the period specified on the data sheet without any interruption.
- 4.16 Charger unit shall comprise Switch Mode Power Supply (SMPS) hot swappable modules to the required number plus two ($n + 2$), to supply the total DC load current and simultaneously charge the battery sets. The SMPS modules shall be mounted on 19 inches racks (min.) within the unit.
- 4.17 The design of the charger unit shall be such that replacement of an SMPS module can easily be carried out and shall be hot swappable. It shall be possible to attend to any individual charger circuit for maintenance without any shutdown or downtime of the system.
- 4.18 The Charger efficiency shall be greater than 92% and power factor shall be minimum 0.92 at - 100% load.
- 4.19 Battery current limit protection shall be provided for SMPS charger. In case battery draws more current than the set value, voltage of Charger shall start decreasing, thus limiting the charging current to the battery.
- 4.20 The charger controller shall have facility to change set points, prepare or examine an event or alarm log, etc. Access to settings and configuration shall be password-protected.
- 4.21 It shall be possible to connect each charger unit with PC via RS232 or USB, & for DCS or SCADA system MODBUS protocol with RS485 standard protocol.
- 4.22 Each Charger unit shall be provided with a digital controller, which shall be based on microprocessor architecture so as to provide integrated control, monitoring and signaling of charger units. Minimum functions of Controller shall be float charging, boost charging, charge current limitation and battery current limitation. Operating- status and diagnostic indications shall be provided by liquid crystal displays (LCD) with a keypad driven/touch screen menu.
- Failure of an LED/LCD shall not cause mal operation or affect the correct functioning of the remote common alarm signal. All parameters shall be easily modified at site using the front keypad without any external hardware.
- 4.23 In case of breakdown of the monitoring unit or disturbance in the internal communication bus, all rectifier modules shall revert to their pre-programmed factory settings at default value. This ensures that system stability is not affected and controller can operate further without causing any breakdown of the system
- 4.24 Charger shall have interlock to prevent boost charging when load is connected to bus.



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

5.0 DESCRIPTION OF EQUIPMENT

5.1 SMPS Rectifier Module:

The rectifier module shall be microprocessor controlled, high frequency with active load sharing, designed for single and parallel operation with battery and shall have automatic voltage regulators for a close voltage stability even when AC supply voltage and DC load fluctuates, effective current limiting features, front access design, programmable temperature compensation feature for battery charging and filters on both input and output to minimize input current harmonics (THDi)

<5%. The rectifier module output regulation shall be $\pm 1\%$ or better from no load to full load with an input power supply variation of $\pm 10\%$ in voltage and +3 to -5% in frequency. If SMPS modules are with inbuilt cooling fan, same shall be temperature controlled; speed regulated cooling fans in each individual module. Each rectifier bank shall be rated for 100% load requirement and keep the connected battery full charged and one spare rectifier module.

The rectifier module circuitry shall be of fail-safe design and failure of any component should not result in any rectifier bank output voltage to increase beyond acceptable limits of the system being fed from it.

The rectifier module shall have slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energized.

The rectifier module shall be fed from 415V AC, 50 HZ; 3 phase, 3 wire system.

The full load efficiency at nominal input and output shall be 92%. The ripple content shall be limited to $\pm 1\%$ of Charger output voltage.

The rectifier module design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. This feature shall be demonstrated during factory testing and various loads.

The controller shall be intelligent, microprocessor controlled for monitoring & control of rectifier modules with features viz. Auto/manual on line battery test function, float/boost mode control etc. All software as required for smooth operation and monitoring of rectifier modules in conjunction with controller.

5.2 Rectifier transformer and Chokes

SMPS modules shall be provided with inbuilt high frequency transformer & filter circuits to reduce the output ripple.

5.3 Blocking Diode

Blocking Diode shall be provided in the output circuit of each rectifier module to prevent current flow from the DC battery into the charger

5.4 Voltage regulators

5.4.1 The Voltage regulation shall be inbuilt feature of Controller. Auto/manual function



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART – A)

shall be selected through the controller.

- 5.4.2 Controller shall be facility to set the voltage as required for fully discharge battery to fully charge battery in Float/Boost Mode.

5.5 Printed Circuit Boards (PCB)

PCB shall be made of glass epoxy of 1.6 mm thick, fire resistant, bonded with 99.8% pure copper foil, free of wrinkles, blisters, scratches and pinholes. The contact surface of the edge connectors of PCBs shall be plated with hard gold to a minimum thickness of 5 microns. The component identification shall be printed on PCB by Silk screen method. All PCBs shall be tropicalized and masked.

5.6 Control and Selector Switches

The control and selector switches shall be of rotary stayput type with escutcheon plates showing functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. The switches shall have shrouded live parts and sealed contacts against dust ingress. The contact ratings shall be at least the following:

- Make and carry continuously 10A
- Breaking current at 220V DC 0.5A (inductive)
- Breaking current at 240V AC 5.0A at 0.3 p.f.

5.7 Indicating Lamps

To indicate AC supply availability, three indicating lamps shall be provided. The indicating lamp shall be suitable for panel mounting, cluster type LED and capable of clear status indication under normal room illumination. The lamp covers shall be preferably screw type, unbreakable and moulded from heat resistant material.

5.8 Instruments

Analog meters shall be provided as AC input ammeter and voltmeter.

5.9 Relays

The relays (if applicable) shall be enclosed in flush or semi flush dust tight cases finished with dull black enamel paint. Relays shall have self-contained test facilities and provisions for removing relay mechanism for inspection and maintenance.

5.10 Transducers

Transducers shall be panel-mounting type and suitable for operating temperatures from 0 to 55°C. Transducer output shall be used for remote display at DDCMIS. Transducers shall be provided in charger panel for DC battery voltage, charger output voltage and charger output current. The transducer shall have the following features:

- Input/ output with galvanic isolation
- Auxiliary voltage – 220V DC
- 4-20 mA independent dual output
- Accuracy class 0.5 or better

5.11 Contactors

All battery chargers shall have an AC contactor on the input side. It shall be of air break type



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

and suitable for continuous duty. The operating coil shall be rated for 415V. The DC contactors shall be single/double pole air break type and suitable for continuous duty.

5.12 Thermal overload relay

A thermal overload relay with single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input, which will trip the contactor.

(a) MCCBs with OLR feature can be provided in place of contactor and thermal over load relay. Auxiliary contacts (NO,NC) shall be provided in MCCB for remote monitoring.

5.13 Air break switches / MCCB

All chargers shall have AC input and DC output switches of air break, single throw, load break and fault make type or MCCB type. The contacts of the switches shall open and close with a snap action. The switches shall be rated for 120% of the maximum continuous load. The 'ON' and 'OFF' position of the switch shall be clearly indicated. The operating handle of the switches shall be fully insulated from circuit and shall be effectively earthed.

5.14 Fuses

Fuses shall be of HRC cartridge fuse link type. Fuses shall be mounted on fuse carriers, which are mounted on fuse base. Wherever, it is not possible to mount fuses on fuse carriers, fuses shall be directly mounted on plug-in type bases. In such cases one insulated fuse pulling handle shall be supplied for each charger. Fuses with alarm contacts shall be provided. The fuses shall be suitable for applicable fault level.

4 nos. Fuse links of each type and rating shall be provided extra for replacement during erection and commissioning.

5.15 Variable Metallic Resistor (Discharge Resistor)

Variable metallic resistors and shunt suitable for carrying out discharge tests on the batteries shall be supplied. The Discharge resistor unit shall be of robust assembly consisting of Copper-Nickel Alloy wire grid elements. The Discharge Resistor fan shall be designed to allow rapid, forced cooling of resistor bank.

Load bank shall be fully automatic with provision for manual operation.

The load bank shall be fan cooled constructed from 2.5 mm zinc coated steel incorporating removable panels for easy access to resistors and fan. The whole assembly shall be mounted onto a fully hot dipped galvanized base. The control and electrical cabinet shall be part of the load bank and shall have doors with lift off hinges and security type locks. All screws, nuts and bolts shall be zinc plated and secured with vibration proof washers and thread locking adhesive.

The load bank shall be constructed as a free standing unit and be self-supporting, vermin proof; with front, side and end panels forming uniform planes without protrusions or sharp edges. Provision shall be made for lifting the unit by the use of crane slings, rollers and fork lift trucks.

The load bank control cabinet doors shall be fitted with neoprene wire reinforced gasket. An anti- condensation heater protected by HRC fuse shall be provided in the control panel.

Load resistors shall be stainless steel, fully moisture-sealed and weather proof IP 32 degree of protection. Resistors shall be calibrated within 5% of their rated value and tested to 2 kV.



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

Cooling fans shall be adequately sized for cooling bank to maintain cabinet temperature at no more than 20°C above ambient temperature. The fans shall have electrical interlocks against fan failure, reverse rotation, air restriction or load bank high temperature. A 5 minute timer shall be provided to run fans after load shutdown.

5.16 Battery fuse box / MCCB

~~Battery fuse / MCCB of adequate rating meeting the load duty cycle shall be supplied. Suppliers have to furnish DC fuse characteristics in support of the rating selected for the Battery Fuse Box. Battery fuse box / MCCB shall have suitable termination arrangement for terminating the incoming & outgoing cables informed during detailed engineering stage. Suitable cable lugs & glands have to be supplied with the equipment.~~

5.17 Panel Construction

The charger panels housing all the equipment shall be indoor, floor mounting, natural/forced air cooled, self-supporting sheet metal enclosed cubicle type. The charger panel and its door&frame shall be fabricated from 2.0 /2.5 mm respectively cold rolled sheet steel and have folded type construction. The bidder shall also supply necessary base frames, anchor bolts and hardware. Removable undrilled gland plates of at least 3.0 mm thick sheet steel and lugs for all cables shall be provided. The lugs for cables shall be made of electrolytic tinned copper. The gland plate shall be of adequate size for accommodating requisite number of cable glands for power and control cables. The charger shall be tropicalised and vermin proof. Ventilation louvers shall be backed with fine brass wire mesh. All door and covers shall be fitted with synthetic rubber/Neoprene gaskets. The panels shall have hinged double leaf doors provided on front and backside for adequate access of charger terminals. All the charger cubicle doors shall be properly earthed. The panels shall comply with at least degree of protection IP-42. Incoming and outgoing cables shall enter from bottom. Suitable cable terminal board with copper cable lugs and double compression brass nickel-plated cable glands shall be provided in each panel for incoming and outgoing cables.

5.18 For Electronic cards unplanned jumpering and track modifications shall not be allowed. Mechanical interlocks to prevent wrong insertion of cards shall be provided. Each card shall have its junction and test points identified.

5.19 The layout of charger components shall be such that their heat losses do not give rise to excessive temperature within the charger panel surface. Location of the electronic modules will be such that temperature rise of the location, in no case, shall exceed 15°C over ambient air temperature outside the charger.

5.20 All the charger panels shall be provided with an illuminating lamp, a 16 Amp socket and space heaters with thermostat. Toggle switches and fuses shall be provided separately for each of the above fittings. Space heaters "ON" indication shall be provided. Two separate grounding pads shall be provided for each panel.

5.21 Locking facility

Locking facility shall be provided as follows:

Float/Boost selection shall be through controller with interlock wherever required.

The charger enclosure door-locking requirement shall be met by the application of



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

padlocks. Padlocking arrangement shall allow ready insertion of the padlock shackle but shall not permit excessive movement of the locked parts with the padlock in position.

5.22 Control wiring

Each panel shall be furnished completely factory wired upto power cable lugs and terminal blocks ready for external connections. The power wiring shall be carried out with 1.1kV grade, PVC insulated cables conforming to IS-1554 (Part-1). The control wiring shall be of 1.1kV grade, 1 core stranded copper wire with colour coded PVC insulation having identification ferrules at both terminal and device end for each wire. Wires shall conform to IS-694 and minimum size of the wire shall not be less than 2.5 mm². The control wiring terminating at electronic card shall not be less than 0.5 mm². The control terminal shall be suitable for connecting two wires with 2.5 mm² stranded copper conductors. All terminals shall be numbered for ease of connections and identification.

Power & control wiring within the panel shall be kept separate. Any terminal or metal work, which remains alive at greater than 415V, when panel door is opened, shall be fully protected by shrouding.

An air clearance of at least 10mm shall be maintained throughout all circuits, except low voltage electronic circuits, right upto the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

5.23 Terminal Blocks

Terminal blocks for all the chargers shall meet the following requirements:

- a) Terminal block shall be 1.1kV grade, minimum 10A rated, one piece moulded complete with insulating barrier, clip on type terminals, washers, nuts and identification strip etc. It shall be similar to Klippon type RSF with insulating material of melamine or equivalent. Marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. Terminal blocks for CT & VT secondary leads shall be provided with links to facilitate testing, isolation, star/delta and earthing. Terminal blocks for CT secondary shall have the short-circuiting facility.
- b) At least 20% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- c) There shall be minimum clearance of 250mm between the terminal blocks and the cable gland plate and 150mm between two rows of terminal blocks.
- d) Control terminal blocks shall be box-clamp type ELMEX 10 mm² or approved equal. 20% spare terminals shall be furnished.

5.24 Cable Lugs

Heavy duty bolt-on termination tinned copper lugs of compression type shall be used in the Charger for power cable termination. Cable lugs shall comply with IS-8309.

5.25 Cable Glands

Cable glands shall conform to BS-6121. Cable glands shall be of double compression type.

Gland plate thickness 3mm / sheet steel



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART – A)

a) **Lugs and glands shall be provided at equipment end** where equipment is in scope of the bidder.

5.26 Panel Earthing

Charger panels shall have fully rated GI ground bus with two ground terminals, one at each end of the panel. Each ground terminal shall have two bolt drillings with GI bolts and nuts suitable for connection to purchaser's ground conductor.

5.27 All bus bars and bus connections shall be of high conductivity aluminum/ aluminum alloy and adequately sized to limit the maximum temperature rise to 40 deg C from ambient temp (55 deg C) under rated load condition. The maximum allowable temperature rise shall be 50 deg C from ambient temp (50 deg C) at silver plated joints. All bus connections shall be silver-plated joined with two bolt connection with plain and spring washers and locknuts

6.0 Deleted

7.00 NAME PLATE AND MARKING

- Nameplates shall be provided for each panel and for each equipment/device mounted on it.
- The material shall be anodized aluminium/lamicoid, 3 mm thick, with white letters on black background.
- Nameplates shall be held by self-tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- Nameplates for panels shall be provided both on the front rear and also inside of the panels.
- Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices both inside & outside of panel.
- Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/ device number. The number may be painted on or adjacent to the instrument or device case.
- Caution notice on suitable metal plate shall be affixed at the back of each panel.

8.0 PAINTING

After fabrication, all surfaces shall be cleaned and pre-treated as per IS:6005. Two coats of lead oxide primer (anti-corrosive) shall be applied after the pre-treatment. Two coats of powder painting with shade no. RAL-7032 or paint shade approved by customer shall be applied for complete panel. Thickness of paint shall be min. 40-50 microns. Protecting peelable compound shall be provided on outside finished surface to protect the painted surface during transportation and site handling.

9.0 PERFORMANCE GUARANTEE



TECHNICAL SPECIFICATION FOR BATTERY CHARGER

SPECIFICATION NO. TB-378-316-016

SECTION II (PART - A)

The bidder shall guarantee that chargers offered shall meet the ratings and performance requirements stipulated for various equipment covered in this specification. If the equipment fails to meet the requirement, the supplier shall replace it with appropriate equipment free of cost without affecting the schedule.

10.0 INSPECTION & TESTING

10.1 The bidder shall furnish their Quality plan during contract stage along with supporting documents. The Quality plan shall be subject to BHEL/ customer approval after award of contract without any commercial or delivery implication. Inspection shall be carried out as per BHEL/ customer approved Quality plan.

10.2 All equipment to be supplied shall be of type-tested quality. The bidder shall furnish all type test reports for BHEL/ customer approval. The Type tests should have been carried out on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have been witnessed by a client/ government agency. In absence of such type tests reports or in case such reports are not found to be meeting the specification/ standards requirements, vendor shall conduct all such type tests without any commercial/ delivery implication to BHEL according to the relevant standards and reports shall be submitted to the owner for approval.

10.3 All tests as per relevant standards and specification, shall be carried out by the manufacturer. Charges for all these tests for all the materials shall be deemed to be included in the bid price quoted by bidder. No separate charges for performance of test shall be paid.

10.4 Routine and type test certificates for components like contactors, relays, instruments, SMPS Modules, Diodes, Condenser, semi-conductors, push buttons to be furnished for review whenever required.

CHAPTER – 20

DC SYSTEM

1.00.00 GENERAL

This system will provide power at 220V DC and 48 V, comprising of batteries, battery chargers and DC distribution Boards (for control, indication and protection of the plant. This system offers continuous power supply to all DC loads for plant normal operation. In addition it will also feed the critical D.C loads during emergency following total loss of AC supply in the plant.

2.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein, 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 (IS codes, Standards etc.) referred to herein, the former shall prevail. All works shall be carried out as per the following standards and codes:

IS: 10918: Specification for vented type Nickel Cadmium Batteries.

IS: 1069: Quality tolerances for water for storage batteries

IEEE: 1115: Recommended practice for sizing of Ni-Cd batteries for stationary applications.

Indian Electricity Rules

Indian Electricity Acts

Battery chargers shall be as per the following standards and codes:

For reference purpose only

ANSI-C 37.90a Guide for surge withstand capability tests

IS: 5: Colours for ready mix paints.

IS: 694: PVC Insulated Cable for working voltages upto and including 1100V

IS: 1248: Specification for Direct acting indicating analogue electrical measuring instruments.



- IS: 13947 Pt-1: Degree of protection provided by enclosures for low voltage switch gear and control gear.
- IS: 13947: Specification for low voltage switch gear and control gear
- IS: 3231: Electrical relays for power system protection.
- IS: 3842: Application guide for Electrical relays for AC System
- IS: 3895: Mono-crystalline semi-conductor Rectifier Cells and Stacks
- IS: 4540: Mono crystalline semi-conductor Rectifier assemblies and equipment.
- IS: 6005: Code of practice for phosphating of Iron and Steel
- IS: 6619: Safety Code for Semi-conductor Rectifier Equipment.
- IS: 6875: Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages up to 1000 VAC or 1200VDC
- IS: 9000: Basic environmental testing procedures for electronic and electrical items.
- IS: 13703: Low voltage fuses for voltages not exceeding 1000 V AC, 1500VDC.
- EEUA-45D Performance requirements for electrical Alarm Annunciation system

Equipment complying with other internationally accepted standards such as IEC, BS, and VDE etc. can also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 DESIGN CRITERIA

3.01.00 Duty Cycle For reference purpose only

The duty cycle shall be decided based on following considerations:

1. Momentary load (1 minute)
 - a) Tripping/closing load of breakers
 - b) Starting current of DC drives
 - c) Solenoid valves
 - d) Excitation system
2. Emergency load & Continuous load (2 hours)
 - a) Running currents of DC motors (emergency oil pump, jacking oil pump, seal oil pump)



- b) Emergency lighting
- c) PA system
- d) Annunciation (20 %)
- e) Indicating lamp of switchgears and control panels
- f) Control room emergency lighting
- g) Auxiliary relays
- h) Numerical relays

3.02.00**Sizing Criteria**

For reference purpose only

Following factors shall be considered while carrying out battery sizing calculations:

- a) Ageing factor- 1.25
- b) Design margin- 1.0
- c) State of charge- 0.9

End cell voltage shall not be less than 1.14 V per cell.

Float charger will be rated to cater the following:

- (a) Trickle charging current of the battery
- (b) Continuous load on the DC bus
- (c) Full load current of the largest DC motor
- (d) 25% margin on Total.

The boost charger unit shall be rated such that the battery can be charged from fully discharged condition within 10 hours.

3.03.00

220 V DC power supply is required for supplying power to essential unit auxiliaries, control, protection, interlock and annunciation. As such the following shall be provided:

- ~~a) 2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for main plant and station loads of each unit.~~
- ~~b) 2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for Coal Handling plant.~~



- c) ~~2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for Ash handling plant.~~
- d) ~~2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for Water Treatment plant and RO Plant.~~
- e) 2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for 400 kV GIS.
- f) ~~2 X 100% set of 220V Ni-Cd battery with associated SMPS based modular float cum boost charger for 33/11 kV Switchgear at ICHS stage I & Sea Water intake.~~
- g) 2x100% rated 48 V Ni-Cd battery with redundant SMPS based float cum boost charger and a common DCDB for EPABX system.

3.04.00 In addition to the above, one no. spare float cum boost charger shall also be provided for above described system (a).

3.05.00 The unit auxiliaries for which emergency power supply from the DC storage battery is required are listed below:

- a) minimum emergency lighting system for reduced illumination during failure of main power supply
- b) ~~Hydrogen seal oil system~~
- c) ~~TG bearing oil system (emergency lubricating oil pump)~~
- d) ~~Aux control supply for 11 KV unit and station SWGRs and 3.3 KV & 415 V SWGRs~~
- e) Electrical protection system
- f) ~~Turbine DC Jacking oil pumps (for main turbine & BFP turbine)~~
- g) Any other emergency load considered necessary.

3.06.00 General Technical Particulars for Battery and Battery Chargers

1.0	DC SYSTEM		
1.1	Type of charger		Combined float-cum-boost



1.2	DC system voltage (Nominal)		220 V
1.3	DC system earthing		Unearthed
1.4	Ambient design temperature	⁰ C	50
2.0	BATTERY DETAILS	For reference purpose only	
2.1	Battery Type		Ni-Cd fibre plate type
2.2	Nominal cell voltage	V	1.2
2.3	End cell voltage	V	1.14
2.4	Discharge capacity	Hr	5
2.5	Ageing factor		1.25
2.6	Design margin		20%
2.7	Float charging voltage		1.4V to 1.42 V
2.8	Boost charging voltage		1.54 to 1.7 V

3.0	BATTERY CHARGER DETAILS		
3.1	DC voltage setting adjustment of AVR for float charging		± 10% of nominal voltage
3.2	Voltage stabilization for constant voltage regulator	(i)	±1% of set DC voltage for ± 10% voltage and +3% to



				-5% frequency variation in power supply
			(ii)	$\pm 5\%$ during transients
3.3	DC current adjustment for boost charging			30% to 100% of maximum boost charging current
3.4	Current stabilization for constant current regulator for boost charger			$\pm 2\%$
3.5	Minimum permissible p.f. at rated continuous load			0.8
3.6	Permissible ripple content at rated continuous load			1% maximum
3.7	Degree of protection			IP 42

4.00.00 GENERAL TECHNICAL REQUIREMENTS FOR EQUIPMENTS

4.01.00 Batteries For reference purpose only

4.01.01 Type

DC Batteries shall be stationary Nickel Cadmium fibre plate type conforming to IS: 10918. The batteries shall be high discharge performance type as specified. For the purpose of design an ambient temperature of 50 degree centigrade and relative humidity of 85% shall be considered.

DC batteries shall be suitable for standby duty. The batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies are lost. Batteries shall be suitable for a long life under continuous float operations and occasional discharges. The batteries shall be boost charged at about 1.54 to 1.7 volts per cell maximum and float charged at about 1.42 V/cell.



Minimum battery back up duration shall be 2 hours and shall be in line with battery duty cycles applicable for power plant emergency supplies. In addition 20% margin shall be provided.

The nominal discharge voltage/cell shall be 1.2V.

Batteries should be suitable for continuous operation for the maximum ambient temperature as defined in technical parameters.

4.01.02

Construction Features

a) Manufacturer's Identification system:

The following information shall be indelibly marked on outside of each cell:

- Manufacturer's name and trade marks
- Country and year of manufacture
- Manufacturer type designation
- AH capacity at 5 hr discharge rate
- Serial number

b) Containers

Containers shall be made of polypropylene or equivalent plastic material. Containers shall be robust, heat resistance, leak proof, non absorbent, alkali resistant, non-bulging type and free from flaws, such as wrinkles, cracks, blisters, pin holes etc. Electrolyte level lines shall be marked on container in case of translucent containers.

c) Vent Plugs

Vent plugs shall be provided in each cell. They shall be anti splash type, having more than one exit hole shall allow the gases to escape freely but shall prevent alkali from coming out. The design shall be such that the water loss due to evaporation is kept to minimum. In addition the ventilator shall be easily removed for topping up the cells and of such dimensions that the syringe type hydrometer can be inserted into the vent to take electrolyte samples.



d) Plates

The plates shall be designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. The construction of plates shall conform to latest revisions of IS: 10918.

The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely. Separators should be suitable for continuous immersion in the electrolyte without distortion.

The positive and negative terminal posts shall be clearly marked.

e) Sediment Space

Sufficient sediment space shall be provided so that cells will not have to be cleaned during normal life and prevent shorts within the cells.

f) Cell Insulator

Each cell shall be separately supported on PVC/porcelain/hard rubber insulators fixed on to the racks with adequate clearance between adjacent cells. Minimum distance between the adjacent cells shall be more than the bulge allowed for two cells in accordance with IS: 1146.

g) Electrolyte

The electrolyte shall be prepared from battery grade potassium hydroxide conforming to BS: 1069/IEC 60993

The cells can be shipped either in charged condition or in dry condition

Necessary electrolyte for make-up shall be supplied separately.

h) Connectors and Fasteners

Nickel coated copper connectors shall be used for connecting up adjacent cells and rows. Bolts, nuts and washers shall be effectively Nickel coated to prevent corrosion. The thickness of Nickel coating of connectors should be not less than 0.02 mm. All the terminals and cells inter-connectors shall be fully insulated or have insulation shrouds. End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded aluminium conductors and XLPE insulation. Necessary supports and lugs for termination of these cables on batteries shall also be supplied. All connectors and lugs shall be capable of continuously carrying the 30 minutes discharge current of the respective



batteries and through fault short circuit current which the battery can produce and withstand for the period declared.

i) Battery racks

Mild steel racks for all the batteries shall be provided. They shall be free standing type mounted on porcelain/hard rubber/PVC pads insulators. Batteries shall preferably be located in the single tier arrangement. However, batteries having a complete cell weight of lower than 50 Kg could be located in the double tier arrangement. The batteries racks and supports for cable termination shall be coated with three (3) coats of anti-alkali paint of approved shade. Name plates, resistant to alkali, for each cell shall be attached on to the necessary racks. The bottom tier of the stand shall not be less than 150 mm above the floor.

Wherever racks are transported in dismantled conditions, match markings shall be provided to facilitate easy assembly.

The Battery shall be provided with earth leakage detector. The battery distribution board should have earth leakage monitoring equipment for the DC feeders taking off from the panel.

j) Load Banks

A separate resistor load bank shall be provided for testing of batteries.

Load Bank shall be resistive/reactive type and shall be suitable for testing the generator on full load. The load bank shall be suitable for outdoor application with degree of protection IP 55. Load bank shall be fully automatic with provision for manual operation.

Constructional features:

The load bank shall be fan cooled constructed from 2.5 mm zinc coated steel incorporating removable panels for easy access to resistors and fan. The whole assembly shall be mounted onto a fully hot dipped galvanized base. The control and electrical cabinet shall be part of the load bank and shall have doors with lift off hinges and security type locks. All screws, nuts and bolts shall be zinc plated and secured with vibration proof washers and thread locking adhesive.

The load bank shall be constructed as a free standing unit and be self supporting, vermin proof; with front, side and end panels forming uniform planes without



protrusions or sharp edges. Provision shall be made for lifting the unit by the use of crane slings, rollers and fork lift trucks.

The load bank control cabinet doors shall be fitted with neoprene wire reinforced gasket. An anti-condensation heater protected by HRC fuse shall be provided in the control panel.

Load resistors shall be stainless steel, fully moisture-sealed and weather proof IP 65 degree of protection. Resistors shall be calibrated within 5% of their rated value and tested to 2 kV.

Cooling fans shall be adequately sized for cooling bank to maintain cabinet temperature at no more than 20°C above ambient temperature. The fans shall have electrical interlocks against fan failure, reverse rotation, air restriction or load bank high temperature. A 5 minute timer shall be provided to run fans after load shutdown.

4.02.00 Battery Charger

4.02.01 General

- a) The charger shall be natural air cooled, SMPS mode type (microprocessor based only) with full wave, fully controlled, bridge configurations. (SMPS modules shall be n+2, n is no. of modules for rated capacity)
- b) The charger shall be provided with automatic voltage regulation, current limiting circuitry, smoothing filter circuit and soft-start feature.
- c) Voltage control shall be stepless, smooth and continuous.
- d) The charger shall be self-protecting against all A.C. & D.C. transients and steady state abnormal currents and voltages.
- e) Charger A.C. input and D.C. output shall be electrically isolated from each other and also from panel ground.
- f) Isolation shall also be provided between power and control circuits.
- g) In case of chargers, both negative and positive isolations shall be achieved.

4.02.02 Interlocks

Necessary interlock shall also be provided to avoid accidental boost mode operation when loads are connected to the bus.



4.02.03 General Technical Requirement

- a) The Battery Chargers as well as their automatic regulators shall be of static type. Battery chargers shall be capable of continuous operation at the respective rated load in Trickle mode i.e. Trickle charging the associated DC Nickel-Cadmium fibre plate Batteries while supplying the DC loads
- b) Battery Chargers shall have a selector switch for selecting the battery charging mode i.e. whether Trickle or Boost charging.
- c) All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/ current control, whether automatic or manual. Means shall be provided to avoid current/ voltage surges of harmful magnitude/ nature which may arise during changeover from Auto to Manual mode or vice-versa under normal operating condition.
- d) Soft start features shall be provided to build up the voltage to the set value slowly within fifteen seconds. The chargers shall have load limiters which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the load limiter setting of the charger. The load limiter characteristic shall be such that any sustained overload or short circuit in DC system shall not damage the charger, nor shall it cause blowing of any of the charger fuses. The charger shall not trip on overload or external short circuit. After clearance of fault, the charger voltage shall build up automatically when working in automatic mode.
- e) When on automatic control mode during Trickle charging, the Charger output voltage shall remain within $(\pm)1\%$ of the set DC value for AC input voltage variation of $(\pm)10\%$, frequency variation of $(+)-3$ to $(-)-5\%$, a combined voltage and frequency (absolute sum) variation of 10% and a continuous DC load variation from zero to full load. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire Trickle charging output range specified. Step less adjustment of the load limiter setting shall also be possible from 80% to 100% of the rated output current for Trickle charging mode



- f) During Boost charging, the Battery Chargers shall operate on constant current mode (When automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode. The charger output voltage shall automatically go on rising, when it is operating on boost mode, as the battery charges up. For limiting the output voltage of the charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage anywhere in the output range specified for boost charging mode. All voltage and current setting potentiometers shall be vernier type.
- g) Energizing the Charger with fully charged battery connected plus 10% load shall not result in output voltage greater than 110% of the voltage setting. Time taken to stabilize, to within the specified limits as mentioned elsewhere shall be less than fifteen seconds.
- h) Momentary output voltage of the Charger, with the Battery connected shall be within 94% to 106% of the voltage setting during sudden load Change from 100% to 20% of full load or vice-versa. Output voltage shall return to, and remain, within the limits specified as mentioned elsewhere in less than 2 seconds after the above mentioned change.
- i) The Charger manufacturer may offer an arrangement in which the voltage setting device for Trickle charging mode is also used as output voltage limit setting device for Boost charging mode, and the load limiter of the trickle charging mode is also used as Boost charging current setting device.
- j) Suitable filter circuits shall be provided in all the Chargers to limit the ripple content (peak to peak) in the output voltage to 1% irrespective of the DC load, even when they are not connected to a battery.
- k) The DC System shall be ungrounded and float with respect to the ground potential when healthy. An earth fault relay shall be provided in the DC distribution board for remote annunciation.
- l) Necessary separation walls for the UPS charger, panels and the batteries in battery room shall be provided.



4.02.04 Contactors

All Battery Chargers shall have an AC contactor on the input side. It shall be of air break type and suitable for continuous duty. The operating coil shall be rated for 400 Volts AC.

4.02.05 Thermal Overload Relay

A thermal overload relay incorporating a distinct single phasing protection (using differential movement of bimetal strips) shall also be provided for the AC input. The relay shall trip the above contactor.

4.02.06 Charger shall be SMPS type and shall have following features:

- Pulse width modulation
- High frequency DC/AC converting
- Voltage stabilization tolerance: $\leq \pm 0.5\%$
- Current stabilization tolerance: $\leq \pm 0.5\%$
- Ripple coefficient: $\leq 0.05\%$
- Power factor: ≥ 0.92
- Efficiency: $\geq 92\%$
- Standby mode: **N+2 module online**
- MTBF: $\geq 100,000$ h
- Remote control functions
- Modular Design
- LCD Control Display Panel
- Multi-Point Monitoring
- Remote Communication
- Software Programmable (PLC Based)
- AC Ripple $< 0.5\%$
- Dynamic Response < 100 micro. sec.
- THD $< 5\%$
- Enhance earth fault monitoring
- Tunable Output
- Intelligent float boost & equalize charging
- Temperature compensated charging for VRLA
- Calculating battery charge/ discharge capacity
- Discharge calculation with K factor & temperature compensation
- Monitoring of each DC feeder status
- Total control on each charging module
- Storing historic alarms
- Remote communication with RS 232 & 485
- Individual cell monitoring
- Ground fault identification suitable for opto-coupler loads
- Identifies faulty feeders



- Monitors insulation level of feeders
- Both positive & negative monitoring

4.02.07 Instruments

DC voltmeter, DC ammeter and AC voltmeter in 96 mm square shall be provided for all Chargers. The instruments shall be flush mounted type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustments. The instruments shall be of 1.5 accuracy class.

4.02.08 Air Break Switches

All Chargers shall have AC input and DC output switches of air break, single throw, load break and fault make type. The contacts of the switches shall open and close with a snap action. Switches shall be rated for 120% of the maximum continuous load. 'ON' and 'OFF' position of the switch shall be clearly indicated.

4.02.09 Control and Selector switches

Control and selector switches shall be of rotary stay-put type with escutcheon plates showing the functions and positions. The switches shall be of sturdy construction and suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred. The contact ratings shall be at least the following:

- Make and carry continuously – 10 Amps.
- Breaking current at 220 V DC – 0.5 Amp. (Inductive)
- Breaking current at 240 V AC – 5 Amp at 0.3 p.f.

4.02.10 Annunciation System

a) One (1) fifteen points alarm facia shall be provided on each charger panel, complete with proper actuating devices, circuitry and legends for the following:

1. A.C. supply failure
2. D.C. voltage lows for Boost & float charger separately
3. D.C. voltage high for boost & float charger separately



4. D. C. System grounds
5. Battery on Float
6. Battery on boost
7. Charger overload for boost charger separately
8. DC output fuse blown for boost & float charger separately.
9. Charger failure
10. Two 2 nos. spare
11. Load limiter operated
12. Any other alarm point, if required for battery charger shall be provided.

Note: Initial contacts for alarm points shall have electrically separate spare set of contacts wired up to the terminal block for future use.

- b) The arrangement shall be such that on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button is pressed.
- c) Each time a window lights up, a master relay will get energised to provide group alarm signals for Owner's remote panel.

4.02.11 Following minimum indications shall be provided

1. DC supply healthy
2. Control supply ON
3. Charger power supply ON
4. Charger DC output healthy
5. Float charger ON
6. Float charger Fail
7. Boost charger in operation
8. Float cum boost charger in boost mode
9. Float cum boost charger in float mode
10. SMPS Module failed

4.02.12 Fault indicating lamps shall be provided on the charger cubicle and following initiating contacts shall be provided for remote alarm for each of the float and boost chargers. The alarms shall be provided on the E D M S / DDCMIS.



- Main AC failure
- Charger AC input fuse blown
- Charger DC output fuse blown
- Charger U/V and current limit protection
- Charger Over voltage protection
- Charger Over current protection
- Charger Filter condenser fuse blown
- Charger Rectifier fuse blown
- Tap Contactor off
- DC Voltage
- Charger Current & Voltage
- DC System ground
- Battery on Boost
- Battery on Float
- SMPS Module failed

4.02.13 Blocking Diode

Blocking diode shall be provided in the output circuit of each Charger to prevent current flow from the D.C. Battery into the Charger.

4.02.14 Construction

- a) The charger shall comprise a continuous line up of free-standing, floor mounted sheet steel panels, with all access from the front.
- b) The panel shall conform to the degree of protection IP-42. The panels shall be manufactured from cold rolled sheet steel of minimum 2 mm thickness with doors and base frame of minimum 2.5 mm thick cold rolled sheet.
- c) Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvers shall be covered with fine wire mesh.
- d) All equipment within the panels shall be arranged in modular units and laid out with sufficient space for easy maintenance.
- e) Switches, meters, relays etc. shall be flush mounted on the front of the panels. Nameplates of approved size and type shall be provided for all circuits and devices.



4.02.15 Charger Equipment

- a) All power diodes and control rectifiers shall be silicon type. Rectifier transformers shall be dry type, double wound, with copper conductor and class-B insulation. The maximum temperature of the class-B insulation shall be limited to that of class-A insulation.
- b) Blocking diodes shall be fully rated and redundant so that failure of a single diode shall not incapacitate the system in any way.
- c) Isolating switches shall be heavy duty, load break type, operated by an external handle with provision for padlocking in ON and OFF position.
- d) Changeover switch shall be 3 position, 4 pole, load break type with minimum 2 NO + 2 NC auxiliary contacts. The switch shall be installed in such a manner that the operating handle shall be accessible only after opening the front door.
- e) Contactors shall be air-break type. Thermal overload relays shall have in-built single phasing preventer.
- f) Fuses shall be HRC type and arranged for easy replacement. Semiconducting device fuses shall be fast-acting.
- g) Indicating Lamps shall be LED type.
- h) Meters shall be 96 x 96 mm switchboard type, 90 deg scale, antiglare glass, 1% accuracy with zero adjuster on the front.
- i) Rectifier transformer for float-cum-boost charger shall be provided with 2x2.5% taps on the primary side.

4.02.16 Controls

The following manual controls shall be provided on the front of the panel:

- a) Selection of float, equalizing or boost charge.
- b) Voltage setters for setting the output of float/equalizing/boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting other.
- c) Current limit setter.
- d) Alarm window reset button.

4.02.17 Lamp/Space Heater/Receptacle

- a) The charger panels shall be provided with:



1. Internal illumination lamp with door switch.
2. Space heater with thermostat control.
3. 3-pin 5A receptacle with plug.

b) Lamp, heater and receptacle circuits shall have individual switch fuse units.

4.02.18 Wiring/Cabling

- a) The panels shall be completely wired-up. All wiring shall be routed through wiring troughs. Wires shall be ferruled at both ends for identification.
- b) Panels shall have removable gland plates at the bottom for cable entry. All incoming/outgoing cables shall be terminated in suitable terminal blocks.
- c) Control terminal blocks shall be box-clamp type ELMEX 10 mm² or approved equal. 20% spare terminals shall be furnished.
- d) Wiring shall be done with 1100 V grade PVC armoured, multi strand FRLS cables. Minimum wire size shall be 2.5 mm² stranded copper conductor.

4.02.19 Printed circuit Boards (PCB)

PCB shall be made of glass epoxy of 1.6 mm thick, fire resistant, bonded with 99.8% pure copper foil, free of wrinkles, blisters, scratches and pinholes. The contact surface of the edge connectors of the PCBs shall be plated with hard gold to a minimum thickness of 5 microns. Component identification shall be printed on PCB by silk screen method. All PCBs shall be tropicalised & marked.

4.02.20 Grounding

- a) The charger panels shall have fully rated ground bus with two ground terminals, one at each end.
- b) Each terminal shall comprise two-bolt drilling with M10 G.I. bolts and nuts and shall be suitable for connecting to 50 x 6 mm G.S. flat.

4.02.21 Painting

The panels shall be finished in Siemens grey shade (shade RAL 7032) with two coats of synthetic enamel paint. The panels shall have a matt finish to prevent any glare from



surface due to illumination. Inside panels painting shall be as per shade RAL 7032.

4.02.22**Name Plate**

- a) Nameplates shall be provided for each panel and for each equipment/device mounted on it.
- b) The material shall be anodized aluminium/lamicoid, 3 mm thick, with white letters on black background.
- c) Nameplates shall be held by self-tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.
- d) Nameplates for panels shall be provided both on the front rear and also inside of the panels.
- e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices both inside & outside of panel.
- f) Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/ device number. The number may be painted on or adjacent to the instrument or device case.
- g) Caution notice on suitable metal plate shall be affixed at the back of each panel.

5.00.00**BATTERY HEALTH MONITORING SYSTEM (BHMS)**

For reference purpose only

Each set of battery shall be equipped with a battery health monitoring system. BHMS shall be microprocessor based system with hardware and software to monitor the condition of each battery system. It should be possible to analyze the minimum and maximum voltage values of each battery cell so that any damage to battery shall be prevented by pr-active maintenance.

In general the BHMS shall be able to monitor following conditions during a partial discharge against stored characteristics for the type and capacity of battery:

1. Excessive current during charging or discharging
2. Short circuit
3. Over voltage-Overcharging
4. Under voltage-Exceeding preset depth of discharge (DOD) limits
5. Over heating- Exceeding the cell temperature limit
6. Pressure build up inside the cell



The system should be able to test, analyze and predict the battery performance, computing remaining capacity and battery efficiency. The BHMS shall compensate for cell temperature and discharge load current throughout the discharge cycle. The system shall have a programmable event log which shall be secured in the event of total power failure for atleast a period of six months. In addition to local indication and control, the battery monitoring shall also include RS 485 output port to enable battery parameters and alarms to be monitored from plant DDCMIS / EDMS / SAS

7.00.00 LIST OF TESTS TO BE CONDUCTED

7.01.00 Shop Tests

All equipment and components thereof shall be subject to shop tests as per relevant IS standards.

7.01.01 Type tests shall be performed on two cells of each battery.

7.01.02 Tests on battery charger.

Following tests shall be performed on each battery charger

- a) Dielectric tests.
- b) Voltage regulation check from 0 to 100% load with $\pm 10\%$ input voltage variation.
- c) Ripple content measurement.
- d) Heat run test on current limiting value.
- e) D.C short circuit test to prove ability of current limit.
- f) Measurement of transient overshoot/undershoot during switching ON/load throw-off.
- g) Current limiter operation.
- h) Dynamic response test - overshoot/ undershoot in output voltage of the charger as a result of sudden change in load from 100% to 20% and 20% to 100% shall be measured with the batteries connected and disconnected. Output voltage of the charger connected with battery shall be within 94% to 106% of the voltage setting in above conditions and shall return to, and remain, within the limits specified as mentioned elsewhere, in less than 2 seconds (as applicable).



- 7.01.03 h) Test for annunciation system
Routine tests on component parts.
- 7.01.04 a) Burning test for PCB's. Assembled PCB burning test at 70 Deg.C. for seventy-two (72) hours with loaded condition.
- b) Rapid temperature cycling tests at 70 Deg.C. and 0 Deg.C for thirty (30) minutes at each temperature for (five) 5 cycles.
- 7.01.05 Routine and type test certificates for components like contactors, relays, instruments, SCR/PWM transistors, Diodes, Condenser, Potentiometer, semi-conductors, push buttons to be furnished for review whenever required.
- 7.01.06 All routine tests as per applicable standards shall be conducted on the DC board.
- Copy of all type test certificates on identical boards issued by authorized test agency shall be furnished.

7.02.00 Test Certificates

- 7.02.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of Owner.
- 7.02.02 The equipment shall be dispatched from works only after receipt of Owner's written approval of Test Report.
- 7.02.03 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

8.00.00 DRAWINGS, DATA & MANUALS

Following drawings & documents are to be submitted by the Contractor:

- i. Dimensional battery layout diagram in plan & section.
- ii. Connection details of take-off terminals.



- iii. Dimensional general arrangement drawings of battery charger, clearly showing device dispositions, cable entry, space requirement, etc.
- iv. Sectional views of battery charger panels.
- v. Charger foundation plan and loading.
- vi. Charger schematics and wiring diagrams.
- vii. Technical particulars for the switchboard.
- viii. Descriptive literature/pamphlets on switchboard.
- ix. Write up on switchboard construction
- x. Single line diagram showing ratings of all the buses, incomers, ties etc.
- xi. Test reports
- xii. Detailed bill of materials.
- xiii. Any other relevant drawing or data necessary for satisfactory installation, operation, and maintenance.
- xiv. Instruction manuals of battery and battery Charger.
- xv. The manual shall clearly indicate method of installation, check-ups, and tests to be carried out before commissioning of the equipment.
- xvi. The Tenderer may note that the drawings, data and manuals listed above are minimum requirement only. Tenderer shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with their bids.



SECTION – 3

PROJECT INFORMATION AND GENERAL TECHNICAL REQUIREMENTS

INDEX

S.No	Chapter	Sheet No.
1.0	Project Synopsis	1
2.0	General Technical Requirements.....	5
3.0	Painting.....	37
4.0	Drawing Document Submission	42

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

1.2 Location

The proposed site for main power plant is located near Ennore port (approx 5 kms).

The nearest Railway station is at Athipattu Pudunagar (approx 5 kms)

All weather road from Pattamandri on the Thiruvottiur-Ponneri district highway is the nearest road access.

The nearest airport is at Chennai at a distance of 60 km.

1.3 NA

1.4 PROJECT INFORMATION

Project Title : **2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**

Owner : **TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude : 13⁰17' N to 13⁰18' N

Longitude : 80⁰18' E to 80⁰19' E

Distance from Chennai City : 35 km

Nearest Airport is at Chennai at a

Distance of : 60 km

Nearest Seaport is : Ennore

Nearest Railway Station is : Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data	:		
Ambient temp. (°C)	:	Annual Maximum Mean Temp	41.5(°C)
	:	Annual Minimum Mean Temp	24(°C)
	:	Design Ambient temperature	50(°C)
Relative Humidity	:	Maximum 100% Minimum 36% Design 75%	
Annual Rainfall	:	Maximum 2540 mm Average 1600 mm Minimum 1175 mm	
Prevailing Wind Direction	:	Nov to Jan – From NW & NE Feb to Mar – From East & SE Apr to May – From South & SE June – From SW July to Aug – From NW Sept to Oct – From SE & SW Wind Speed 11.8 kmph (avg) 50 kmph (max)	

Seismic Zone	:	Seismic Zone III as per IS:1893-2002 minimum 0.16 g horizontal	
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1.5

1.7

Access to Site

Site is well connected to all weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

CHAPTER – 2

GENERAL TECHNICAL REQUIREMENTS

1.00.00 ELECTRICAL SYSTEM PARTICULARS

1) Standard voltage levels

The standardized voltage levels as shall be adopted as specified elsewhere in this specification.

2) Permissible variations:

The system unit/plant equipment shall be designed suitable for continuous operation with variation in voltage and frequency as indicated below:

3) Variation in voltage and frequency

	Voltage	Frequency
Permissible variation for power supply with rated Performance /rated current and control effectiveness maintained	+/- 10%	-5% to +3%
Permissible variation for control and regulation equipment with rated Performance and control quality maintained		

4) Basic insulation levels

Equipment shall be designed suitable for basic insulation levels as given below:

Nominal Voltage (kV)	BIL kV (peak)
400 kV	1425
33 kV	170
11 kV	75
3.3 kV	40

5) Symmetrical short circuit ratings

The three phase symmetrical short circuit ratings of the switchgear at different voltage levels shall be as indicated in the Table below:

S. No.	Voltage level	Symmetrical Breaking Capacity	Making Capacity
1.	400 kV	63 kA for 1 sec	163 kA
2.	33 kV	25 kA for 3 sec	62.5 kA
3.	11 kV	50 kA for 3 sec	125 kA
4.	3.3 kV	40 kA for 3 sec	100 kA
5.	415 V	50 kA for 1 sec	125 kA
6.	220 V DC	25 kA for 1 sec	-
7.	48 V DC	10 kA for 1 sec	

6) Criteria for selection of voltage levels for motors

Sr. No	Rating	Voltage Level
1	LV Motors- Up to 160 kW	415 V, 3 phase, 50 Hz
2	MV Motors- More than 160 kW and up to 1500 kW	3.3 kV, 3 phase, 50 Hz
3	HV Motors- Above 1500 kW	11 kV, 3 phase, 50 Hz

7) System Earthing

- i. 33kV/11 kV and 3.3 kV : Resistance grounded.
- ii. 415 V : Solidly grounded.

8) Degree of Protection:

Degree of protection for various electrical equipment shall be as follows:

S.No.	Equipment	Degree of Protection
1.	Marshalling Boxes, Panels, Motors located outdoor	IP55
2.	Electrical Equipment of CH System	IP55 with dust proof enclosure
3.	HV Switchgear	IP-4X for bus bar chamber, IP-6X for other compartments
4.	LV Switchgear	IP52 up to 1600 A and IP42 above 1600 A

2.00.00 GENERAL TECHNICAL PARTICULARS FOR EHV SYSTEM

(a)	Rated voltage	400 kV
(b)	Rated frequency	50 Hz
(c)	Rated short time current withstand capacity	63 kA rms for one (1) second
(d)	Rated one minute power frequency withstand voltage	650 kV rms between live terminals and earth b) 815 kV rms across isolating distance
(e)	Rated lightning impulse withstand voltage	a) 1425 kVp between live terminals b) 1425 (+240) kVp across isolating distance & earth.
(f)	Rated Switching Impulse withstand voltage	a) 1575 kVp (between phases) b) 900 (+345) (across isolating distance)
(g)	Phase to phase spacing	4000 mm
(h)	Rated terminal load	Adequate to withstand 100 kg static load as well as wind, seismic and short circuit forces without impairing reliability or current carrying capacity.
(i)	System neutral earthing	Effectively earthed
(j)	Support structure height	Adequate so that lowest part of support insulator of equipment is 2550 mm (minimum) from ground and/or plinth level.
(k)	Creepage distance	Minimum 31 mm / kV
(l)	Electrical Clearances	

Clearances shall be as given below and as per relevant statutory rules/codes.		
1.	Phase to earth	3500 mm
2.	Phase to phase	4000 mm
3.	Sectional clearance	6500 mm
4.	Ground clearance	8000 mm

3.00.00 NA

4.00.00 COMPLETENESS

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 Bidder 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 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 (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 Organisation 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, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Owner'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 else

where in the specification together with the complete word to word translation of the standard that is normally not published in English.

~~5.04.00~~ — NA

5.05.00 NA

5.06.00 NA

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 Owner shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Bidder to bring to the notice of the Owner such changes and advise Owner of the resulting effect.

6.00.00 EQUIPMENT FUNCTIONAL GUARANTEE

6.01.00 The Equipment and Auxiliaries shall be capable of continuous operation in frequency range of 47.5 to 51.5 Hz.

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 Bidder shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinate 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.

7.02.00 Maintenance and Availability Considerations

Equipment 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.

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 maintenance manuals, clearly defining the spare parts and man-hour requirement for each stage.

8.00.00 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY BIDDER

8.01.00 Each of the 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 as per the scope.

The Bidder shall furnish engineering data/drgs. in accordance with the schedule of information as specified in Technical Specification and data sheets.

- 8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of documents is given in Chapter 4.
- 8.03.00 The documentation that shall be provided by the Bidder is indicated in various sections of specification. The documentation shall include but not be limited to the following:

Basic Engineering Documentation

Prior to commencement of the detailed engineering work, the Bidder shall furnish a Equipment Definition Manual within 4-6 weeks from the date of the Purchase Order. This manual shall contain the following as a minimum:

- i. System description of all the mechanical, electrical, control & civil systems.
- ii. Technology scan for each system / sub-system & equipment.
- iii. Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.
- iv. NA.
- v. Sizing criteria of all the systems, sub-systems including various equipment/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.
- vi. Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.
- vii. Operation Philosophy and the control philosophy.
- viii. General Layout plan.
- ix. NA
- x. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xi. NA
- xii. NA
- i. Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
- ii. NA

- iii. NA
- iv. NA
- v. NA
- vi. Technical data sheets for all bought out and manufactured items. Bidder shall use the specifications as a base for placement of orders on their sub-vendors.
- vii. Detailed design calculations for components, system/sub-system, etc., wherever applicable including sizing calculations as per criteria specified elsewhere in specification.
- viii. NA
- ix. NA
- x. NA
- xi. NA
- xii. NA
- xiii. Power supply single line diagram, block logics, control schematics, electrical schematics, etc.
- xiv. NA
- xv. Interconnection diagrams.
- xvi. Cable routing plan.
- xvii. Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring diagrams of panels and enclosures etc.
- xviii. Alarm and annunciation list and alarms & trip set points.
- xix. Sequence and protection interlock schemes.
- xx. Type test reports
- xxi. Control system configuration diagrams and card circuit diagrams and maintenance details.
- xxii. Detailed software manuals & source software listing.
- xxiii. Detailed flow chart for digital control system.
- xxiv. Mimic diagram layout.
- xxv. Civil Task drawings(for the Engineering by BHEL),Design and Drawings.
- xxvi. Model study reports wherever applicable.
- xxvii. NA
- xxviii. Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
- xxix. Documentation in respect of commissioning as listed out elsewhere in this specification.

8.03.01 **Instruction Manuals**

The Bidder shall submit, 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 BHEL / OWNER the Instruction Manuals shall be submitted as indicated in Chapter-4. **The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals with As Built drawings have been supplied.** The Instruction Manuals shall comprise of the following.

Erection Manuals

The erection manuals 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 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

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 BHEL / OWNER 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.
- 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 BHEL / OWNER 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 maloperation or break down.
- v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-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 BHEL / OWNER indicating lubrication method for each type/category of bearing.

8.03.02

Plant Handbook

The Bidder shall submit to the BHEL / OWNER a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various equipment and systems covering the complete project including	
1.	Design and performance data.
2.	Process & Instrumentation diagrams.
3.	Single line diagrams.
4.	Sequence & Protection Interlock Schemes.
5.	Alarm and trip values.
6.	General layout plan
7.	Important Do's & Don't's
8.	The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of BHEL / OWNER's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03

Project Completion Report

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.03.04

Drawings

- (a.) All documents submitted by the Bidder for BHEL / OWNER's review shall be in electronic form (soft copies) **along with the desired**

number of hard copies as per Chapter-4. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.

- (b.) Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Chapter-4.
- (c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to BHEL / OWNER.
- (d.) All documents/text information shall be in latest version of MS Office.
- (e.) All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.
- (f.) Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the BHEL / OWNER, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- (g.) The Bidder shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the BHEL / OWNER. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".
- (h.) Similarly, all the drawings/ documents submitted by the Bidder during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.
- (i.) The furnishing of detailed engineering data and drawings by the Bidder shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Owner will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipment provided by others and external connections & dimensions which might affect plant layout. The review by the Owner should not be construed to be a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy

of the information submitted. The review and/ or approval by the BHEL / OWNER / Project Manager shall not relieve the Bidder of any of his responsibilities and liabilities under this contract.

- (j.) After the approval of the drawings, further work by the Bidder shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the BHEL / OWNER.
- (k.) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Bidder's risk. The Bidder is expected not to make any changes in the design of the equipment /system, once they are approved by the BHEL / OWNER. However, if some changes are necessitated in the design of the equipment/system at a later date, the Bidder may do so, but such changes shall promptly be brought to the notice of the BHEL / OWNER indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.
- (l.) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of BHEL / OWNER prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of BHEL / OWNER based on requirements of such piping indicated in approved / finalized Flow Scheme / Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.
- (m.) Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the Bidder well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.
- (n.) As Built Drawings

After final acceptance of individual equipment/system by the BHEL / OWNER, the Bidder will update all original drawings and documents for the equipment/ system to "as built" conditions.

- (o.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the BHEL / OWNER. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for re-submission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration

of systems, facilities, equipment & works under BHEL/OWNER's scope and submit all necessary drawings/ documents for the same.

- (p.) The Bidder shall submit adequate prints of drawing/data/document for Owner's review and approval. The BHEL/OWNER shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.
- (q.) All engineering data submitted by the Bidder after final process including review and approval by the BHEL/OWNER shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the BHEL/OWNER in writing.

8.04.00 **Engineering Information Submission Schedule**

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the BHEL/OWNER. 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 BHEL/OWNER before proceeding further, and
- (b.) Information that would be submitted for BHEL/OWNER's information only.

The Engineering Information Schedule shall be updated monthwise.

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.

8.05.00 **Engineering Progress and Exception Report**

8.05.01 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.

8.05.02 The draft format for this report shall be furnished to the BHEL/OWNER within four (4) weeks of the award of the contract, which shall then be discussed and finalized with the BHEL/OWNER.

8.06.00 **Co-Ordination Meetings**

8.06.01 The Bidder shall be called upon to attend monthly Design/ Co-ordination Meetings (if required) with the BHEL/OWNER/Owner's representatives, Project Consultant during the period of contract. The Bidder shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

8.06.02 The Bidder should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Bidder shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Bidder will be reviewed by the BHEL/OWNER as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the BHEL/OWNER shall then be discussed across the table during the above co-ordination Meetings wherein best efforts shall be made by both sides to ensure the approval of the drawing.

8.06.03 The Bidder shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Bidder shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

8.06.04 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

8.06.05 Any delays arising out of failure by the Bidder to incorporate Owner's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Bidder to alter the Contract completion date.

8.07.00 **Design Improvements**

The BHEL/OWNER or the Bidder 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 Bidder proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

8.08.00 **NA**

8.09.00 **NA**

8.10.00 **Lubricants, Servo Fluids and Chemicals**

- 8.10.01 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, 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. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.
- 8.11.00 NA**
- 8.12.00 Material of Construction**
- 8.12.01 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.
- 8.13.00 Rating Plates, Name Plates & Labels**
- 8.13.01 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive 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 BHEL/OWNER.
- 8.13.02 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the BHEL/OWNER or as detailed in appropriate section of the technical specifications.
- 8.13.03 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 engraved on the back. The name plates shall be suitably fixed on both front and rear sides.
- 8.13.04 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.
- 8.13.05 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.
- 8.13.06 Valves, steam traps and strainers shall be identified by BHEL/OWNER's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

- 8.13.07 Safety and relief valves shall be provided with the following :
- (a.) Manufacturer's identification.
 - (b.) Nominal inlet and outlet sizes in mm.
 - (c.) Set pressure in Kg/cm² (abs).
 - (d.) Blowdown and accumulation as percentage of set pressure.
 - (e.) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.
- 8.13.08 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.
- 8.13.09 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

8.14.00 **Tools and Tackles**

The Bidder 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 Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the BHEL/OWNER.

8.15.00 **Welding**

- 8.15.01 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be performed by others the requirements shall be submitted to the BHEL/OWNER in advance of commencement of erection work.

8.16.00 **Colour Code for all Equipment/ Pippings/ Pipe Services**

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

8.17.00 **Protection and Preservative Shop Coating**

8.17.01 **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 piping 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.

8.17.02 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 atleast 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 epoxy. The finished colors shall be as per manufacturer's standards, to be selected and specified by the BHEL/OWNER at a later date.

8.17.03 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the BHEL/OWNER regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.

8.17.04 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

8.17.05 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

8.17.06 Painting for Civil structures shall be done as per relevant part of technical specification.

9.00.00 QUALITY ASSURANCE PROGRAMME

9.01.00 The Bidder shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Bidder's works or at his sub-Bidder's premises or at the Owner's site or at any other place of work are in accordance with the specifications. Such programs shall be outlined by the Bidder and shall be finally accepted by the Owner/authorized 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 Bidder shall generally cover the following:

- (a.) His organization 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-Bidder'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 Owner.
- (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.

9.02.00 **General Requirements - Quality Assurance**

9.02.01 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 Bidder 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 Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

- 9.02.02 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 Bidder's/ Sub-Bidder'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. Compact Disc 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.
- 9.02.03 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.
- 9.02.04 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 Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.
- 9.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
- 9.02.06 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.
- 9.02.07 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the format No.: QS-01-QAI-P-02/F3 to be issued at contract stage.
- 9.02.08 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 Owner.

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

- 9.02.09 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder'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 Owner.
- 9.02.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.
- 9.02.11 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.
- 9.02.12 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 9.02.13 No welding shall be carried out on cast iron components for repair.
- 9.02.14 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 9.02.15 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-1A (of the American 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.

- 9.02.16 The Bidder shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors bought out items (BOI). All the sub-Bidder proposed by the Bidder 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 Bidder and finalised with the Owner, shall be subject to Owner's approval. The Bidder'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 Owner for approval within the period agreed at the time of pre-awards discussion and identified in review category prior to any procurement. Monthly progress reports on sub-Bidder detail submission / approval shall be furnished. Such vendor approval shall not relieve the Bidder from any obligation, duty or responsibility under the contract.

- 9.02.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Owner, the Bidder's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-Bidder 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 Owner and such approved Quality Plans shall form a part of the purchase order/contract between the Bidder and sub-Bidder. Within 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 Owner on the monthly basis by the Bidder along with a report of the Purchase Order placed so far for the contract.
- 9.02.18 Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their sub-Bidder's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.
- 9.02.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder'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. Bidder 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.
- 9.02.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner 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 Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 9.02.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.
- 9.02.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.
- 9.02.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment
- All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it 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 deg.C above the ambient temp. at 50 deg.C.

Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in 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.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

9.03.00 QA Documentation Package

The Bidder 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.

9.03.01 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 despatch. However CD-Rom may be issued not later than three weeks.

9.03.02 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 Owner and Bidder for the agreed Customer Hold Points.
 - (h.) Certificate of Conformance (COC) wherever applicable.
 - (i.) MDCC
- 9.03.03 Similarly, the Bidder 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.
- 9.03.04 Before despatch / 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.
 - (c.) If a decision is made despatch, 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 despatch of equipment.

9.03.05 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 Owner.

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

9.04.00 Project Manager's Supervision

9.04.01 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 Owner's Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section General Conditions of Contract, the Bidder shall proceed to comply with the Project Manager's decision.

9.04.02 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 Bidder'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.

9.05.00 Inspection, Testing And Inspection Certificates

9.05.01 The word 'Inspector' shall mean the Project Manager and/or his authorized representative and/or an outside inspection agency acting on behalf of the Owner to inspect and examine the materials and workmanship of the works during its manufacture or erection.

- 9.05.02 The Project Manager or his duly authorized representative and/or an outside inspection agency acting on behalf of the Owner 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 Bidder shall obtain for the Project Manager and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Bidder's own premises or works.
- 9.05.03 The Bidder shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Bidder'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 Bidder 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.
- 9.05.04 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Bidder, 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 Bidder 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.
- 9.05.05 When the factory tests have been completed at the Bidder's or sub-Bidder'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 Bidder's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 9.05.06 In all cases where the contract provides for tests whether at the premises or works of the Bidder or any sub-Bidder, the Bidder, 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 authorized representatives to carry out effectively such tests on the equipment in accordance with the Bidder and shall give facilities to the Project Manager/Inspector or to his authorized representative to accomplish testing.
- 9.05.07 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Bidder in respect of the agreed Quality Assurance Programme forming a part of the contract.

- 9.05.08 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 9.05.03- of this chapter, the Bidder 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.
- 9.05.09 All inspection, measuring and test equipment used by Bidder shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
- 9.06.00 **Associated document for quality assurance programme:**
- 9.06.01 List of items requiring quality plan and sub supplier approval.
- 9.06.02 Status of items requiring Quality Plan and sub supplier approval.
- 9.06.03 Field Welding Schedule
- 9.06.04 Manufacturing Quality Plan
- 9.06.05 Field Quality Plan
Format for the above shall be issued at Contract stage.

10.00.00 PRE-COMMISSIONING AND COMMISSIONING FACILITIES

- (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 Owner and the Bidder 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 Bidder's quality assurance programme as well as those included elsewhere in the Technical Specifications.
- (b.) The Bidder'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, equipment shall be operated integral with sub-systems and supporting equipment as a complete plant.

It will be the responsibility of the Bidder to assess and furnish a list of all commissioning spares required for successful commissioning of all the equipment covered under the contract. Such a list shall be

furnished by the Bidder within 12 months from the date of LOA, separately for each equipment and shall be reviewed by the Owner and discussed for mutual agreement. The commissioning spares will be so identified as not to allow the trial operation to suffer for want of such commissioning spares. The identification of commissioning spares will not in any way relieve the Bidder of any of his responsibilities of satisfactory performance under the provisions of other conditions of contract. All the commissioning spares shall be deemed to be included in scope of the Bidder as a part of the respective equipment package at no extra cost to the Owner.

- (c.) NA
- (d.) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.
- (e.) 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 to Owner's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs (Standard Check List) / TS (Testing Schedule) / CS (Commissioning Schedule)] approved by the Owner.
- (f.) The Bidder during initial operation and performance testing 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.
- (g.) Bidder shall furnish the commissioning organization chart for review & acceptance of Owner at least eighteen months prior to the schedule date of synchronization of 1st unit. The chart should contain :
 - (1.) Biodata including experience of the Commissioning Engineers.
 - (2.) Role and responsibilities of the Commissioning Organisation members.
 - (3.) Expected duration of posting of the above Commissioning Engineers at site.

10.02.00 Initial Operation

- a) On completion of all pre-commissioning activities / tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.
- b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation

- of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.
- c) The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.
 - d) The Bidder shall intimate the Owner about the commencement of initial operation and shall furnish adequate notice to the Owner in this respect.
 - e) Any loss of generation due to constraints attributable to the Owner shall be construed as Deemed Generation.
 - f) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Bidder. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Bidder to the full satisfaction of the Owner to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for withholding the aforesaid permission.

10.03.00 **Guarantee Tests**

- a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule.
- b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.
- c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.
- d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.
- e) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

11.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Owner delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

12.00.00 TRAINING OF OWNER'S PERSONNEL

12.01.00 The scope of service under training of Owner shall include a training module in the areas of Operation & Maintenance.

Such training should cover the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:

(a.) Training for Electric Power Supply systems

The above training shall be provided taken by the Bidder in one of the reference power plant.

12.02.00 The scope of services under training shall also necessarily include training of Owner's Engineering personnel covering a training module of upto 2 man months. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. An indicative module of the training requirement of Owner's Engineering personnel is attached as Annexure-I (BOQ).

12.03.00 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Owner's approval. Consolidated training period included above (i.e. 1 and 2 man months respectively for O&M and Engineering) is indicative only. Owner reserves the right to reappropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

12.04.00 Refer Annexure-II for detailed scope of services under Training.

12.05.00 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.

12.06.00 In all the above cases, wherever the training of Owner's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Owner's personnel shall be at the cost of Bidder. The Bidder shall make all necessary arrangements towards the same.

- 12.07.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Owner reserves the right to include or exclude these item(s) during place of Award. All expenses except travelling expenses shall be borne by the contractor.

13.00.00 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 Owner'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.

14.00.00 NA

15.00.00 PACKAGING AND TRANSPORTATION

All the equipment & spares 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. Each spare shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

- Manufacturer shall furnish detailed Packing list before dispatch of material
- Master Packing List for complete list of Equipment or Material to be furnished to BHEL for this project during detailed Engineering Stage.

The Packed item shall have Marking Plate with following details on Packing:

	BHEL-TBG-Noida-India
NAME OF ITEM	
CONSIGNEE	
MATERIAL	
CUSTOMER REF.	
DESPATCH ADVICE NOTE NO.	
DIMENSIONS (MM) LXBXH	
NET WEIGHT (KG)	
GROSS WEIGHT (KG)	
SPECIAL INSTRUCTIONS	HANDLE WITH CARE – KEEP DRY DO NOT DROP – DO NOT TILT (or manufacturer's instructions)
MO. NO.	
CASE NO.	

16.00.00 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.

17.00.00 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.

17.01.00 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 as follows:

a)	Temperature	-	Degree centigrade (deg C)
b)	Pressure	-	Kilograms per square centimeter (Kg/cm ²). Pressure instrument shall have the unit

			suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
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17.02.00 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.

17.03.00 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 tropicalized & components shall be of industrial grade or better.

18.00.00 ELECTRICAL NOISE CONTROL

The equipment furnished by the Bidder shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Bidder'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.

19.00.00 NA

20.00.00 TAPPING POINTS FOR MEASUREMENTS

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.

- (a.) Temperature test pockets with stub and thermowell
- (b.) Pressure test pockets

21.00.00 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 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.

22.00.00 ENVIRONMENTAL MONITORING & CONTROL MEASURES

Bidder to note that MOEF has declared Manali area as critically polluted area and also imposed certain restrictions on consideration of developmental projects.

Concerned authorities have been addressed to have self monitoring system (for Air, Water & Land) so as to ascertain the level of compliance of standards prescribed by MOEF and also to furnish the action plan ie., for the establishment of self monitoring system. It is also directed to undertake Environmental Audit (EA) to ascertain the compliance level of standards notified by MOEF.

CHAPTER - 3

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.

The following surface and material shall require painting:

- a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
- b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
- c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting :

- a. Non-ferrous materials
- b. Austentic stainless steel
- c. Plastic and / or plastic coated materials
- d. Insulated surface of equipment and pipes except color coating wherever required.
- e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color code.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)
IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)

IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS:2932	:	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	:	Code of practice for lining of vessels & equipment
SIS 559000	:	Swedish standard for blasting
ISO 8504-2	:	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	:	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	:	Surface preparation by acid pickling
SSPC SP08	:	Surface preparation by acid pickling
IS 2629	:	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	:	Standard practice for repair of damaged galvanized coatings
SSPC	:	Steel structures painting council
NACE	:	National association of Corrosion Engineers
DIN	:	Deutsehes Institute for Normung
BS	:	British Standard
ASTM	:	American Society for Testing material
AWWA	:	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied.

Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100C. Blasting activity shall be performed at temperatures 30C above dew point and substrata temperature between 50C & 500C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work.

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).

The grade of blasting shall be performed in line with the approved painting scheme.

The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.

Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement of painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting

(a) Blasting according to SIS 055900, Grade Sa 2½

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

	Impurity	Removal
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	Markings (eg felt up pen)	Organic solvents to manufacturer's specifications eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1 General

Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + 5°C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3°C above dew point.

4.2 Application Procedure

The primer shall be applied by means of brush or by spary. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3 Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturers specification. The final top shall be reapplies completely.

4.4 Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5 Bond Strength

The pill off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm², according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

- (i) All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and

final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.

- (ii) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.
- (iii) Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.
- (iv) Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.
- (v) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

(i) Surface Preparation

Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

(ii) Hot Dip galvanizing

The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m².

(iii) Post Treatment

Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.

(iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A780.

CHAPTER 4

DRAWING DOCUMENT SUBMISSION

4.1 DISCREPANCIES BETWEEN DRAWING AND SPECIFICATION:

Should there be any discrepancy between the specifications and/or schedule of prices and/or drawings or any inconsistency, error or omission in either of them, reference must be made to the BHEL/CUSTOMER for an explanation and the Supplier will be held responsible for any errors that may occur in the work through neglect of this precaution. The explanation of the BHEL/CUSTOMER shall be final and binding on the Supplier.

4.2 APPROVAL PROCEDURE

The scheduled dates for the submission of drawings as well as for, any data/information to be furnished by the Employer would be as per the following schedule. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer. The following schedule shall be followed generally for approval.

i.	First Submission	Within 7 days from the date of LOI/PO
ii.	Approval/comments/by employer on Initial submission	Reasonable time
iii.	Resubmission	Within 7 days (whenever from date of comments required) Including both ways postal time.
iv.	Approval or comments	Within 2 weeks of receipt of resubmission.
v.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer enclosed sheet for details of Title block.

4.3 TITLE BLOCK

Following Title Blocks to be used in drawings at the time of drawing approvals

Project:	400kV GIS at 2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS, Chennai-120
NOA No:	CE/P/SE/M/P/EE-10/E/P/F.2X660MW ENNORE SEZ STTP/D60/DT 27.027.2014
Customer :	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)
Consultant	DESEIN PRIVATE LIMITED, NEW DELHI
Contractor	BHARAT HEAVY ELECTRICALS LIMITED

4.4 DOCUMENTS TO BE SUBMITTED ALONG WITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) List of Part Supplies with rating

Drawings & Documents submitted at the time of offer shall be subject to review at contract stage.

4.5 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION
			Hard Copy / Prints	Hard Copy / Prints CDs
1	Drawings and Data Sheets	1	7	10
2	Drawings "As Built "	-	-	10
3	Type Test Reports	1	7	10
4	Erection Manuals	-	7	10
5	Operation and Maintenance Manuals	-	7	10
6	Manufacturing Quality Plan	-	7	10
7	Field Quality Plan	-	7	10

8	Inspection Test Reports	-	7	10	

Supplier to submit Hard copies of the drawing to following address

To,
<Name of BHEL's concerned engineering official>
Bharat Heavy Electricals Limited
Transmission Business Group- Engineering Management
Advant Navis IT Business Park
Plot No.-7, Greater Noida Expressway,
Sector 142, **NOIDA**, Uttar Pradesh 201305

Note: Drawings will also be submitted in CD/DVD in Latest AUTOCAD version or any other CAD package along with conversion files for all major items.

Final Documentation shall be submitted in bound volumes with details of Customer & Project etc. written on top.

Annexure-A: Schedule of Technical Deviation/(s)

Bidder shall list out all technical deviation(s) along with clause with respect to technical specifications.

<u>Sl. No.</u>	<u>Page No.</u>	<u>Clause No.</u>	<u>Deviation</u>	<u>Reason / Justification</u>
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Bidder's Stamp & Signature

Annexure-B: Compliance Certificate

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.
2. There are no deviation with respect to specification other than those furnished in the 'schedule of deviations'.
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date:

Bidder's Stamp & Signature