



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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BHEL Document No. TB-316-401-010				Rev. 00		Prepared by AK	Checked by VK	Approved by AG
Type of Document Technical Specification				Sign				
Title AC & DC DISTRIBUTION BOARDS FOR 400kV SWITCHYARD				Date	31.03.2020			
				Group	TBEM			
				W.O. No	88006			
CUSTOMER				Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd. (UPRVUNL)				
CONSULTANT				1. NTPC (Review Consultant) 2. DCPL				
PROJECT				400kV Switchyard for Panki Thermal Power Station (1x660MW)				
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Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS			
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PROJECT: 400kV Switchyard for Panki Thermal Power Station (1x660MW)

CUSTOMER: UPRVUNL

REVIEW CONSULTANT: NTPC LTD.

CONSULTANT: DCPL

Technical Specification of AC & DC Distribution Boards

TB-316-401-010

Section-1: Scope, Specific Technical Requirements & Quantities

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SECTION-1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE:

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch, supervision of erection, testing and commissioning of metal enclosed, indoor floor mounted and free standing type AC and DC Distribution Board as listed in clause 1.2 below.

This section covers the scope and quantities of LT AC & DC DB. The specific technical requirements for the above item as specified by the customer are given in Section-2. The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

In case of any discrepancies between the requirements mentioned under Section-1/Section-2 and those specified in the Section-3, the specifications given under Section-1/Section-2 shall prevail and shall be treated as binding requirements.

The term "Owner/Customer/Employer" appearing in this specification shall refer to ultimate customer, the term "Purchaser/Contractor" shall refer to BHEL and the term "Sub-contractor/Bidder/Manufacturer" shall refer to the successful Bidder.

The equipment is required for the following project:

Name of Customer: Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd.
(UPRVUNL)

Name of Project: 400kV Switchyard for Panki Thermal Power Station
(1x660MW)

Name of Consultants: NTPC (Review Consultant)
DCPL, Kolkata

Refer Section - 3 for Project Details and General Specifications.

1.1 SPECIFIC TECHNICAL REQUIREMENTS:

Please refer drawing enclosed as Annexure-SLD:

9962-001-TB-572-PVE-P-192	Single Line Diagram for AC & DC Distribution Board for 400kV Switchyard
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For further technical requirement, refer Section-2.

1.2 BILL OF QUANTITY:

For details of fitments of each module, refer Section 2 and enclosed Single Line diagram.

Annexure-1 attached for Detailed BOQ.

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Fault rating is as per attached S.L.D

1.3 TYPE TESTING, ERECTION, TESTING & COMMISSIONING

- a. Type tests shall be in line with Clause 6.27.02 of Chapter-15A of Section 2.
- b. The type test reports submitted shall be of tests conducted after **02.11.2010**. The bidder should have conducted type test on identical or similar equipment/ components to those offered. In case type test reports are found to be technically unacceptable to BHEL/UPRVUNL/CONSULTANT, the type test shall be conducted without cost and delivery implication to BHEL/UPRVUNL.

1.4 DEVIATIONS

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

1.5 PACKING

- 1.5.1** All equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and outdoor storage (for a minimum period of 1 years) at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of transportation facilities in India should be taken into account. The Bidder shall be responsible for any loss or damage during transportation, handling and storage.
- 1.5.2** The Bidder shall include and provide for security, protection and packing the equipment so as to avoid loss or damage during transport by any mode.
- 1.5.3** All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'UP' and 'DOWN' side of boxes, and handling and unpacking instructions as considered necessary. Special precautions shall be taken to prevent rusting of steel and iron parts during transit and storage. Gas seals or other methods proposed to be adopted for protection against moisture during transit shall be to the satisfaction of the purchaser.
- 1.5.4** The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols i.e. FRAGILE, HANDLE WITH CARE, USE NO HOOKS etc.
- 1.5.5** Each package delivered under the contract shall be marked by the Bidder at his expense and such marking must be distinct (all previous irrelevant marking being carefully obliterated). Such marking shall show the description and quantity of contents, the name of consignee and address, the gross and net weights of the package, the name of Bidder with a distinctive number of mark sufficient for purpose of identification. All markings shall be carried out with such materials as to ensure quickness of drying, fastness and legibility.
- 1.5.6** Each Package shall contain a note quoting specifically the name of the Bidder, the number and date of contract or order and the name of office placing the contract, nomenclature of the stores and include a schedule of parts for each complete equipment giving the parts number with reference to the General Arrangement/ Assembly drawing and the quantity of each part, drawing number and tag numbers.

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1.5.7 All equipment/ material shall be suitably packed for transport, carriage at site and outdoor storage during transit. The Bidder shall be responsible for any damage to the equipment during transit. The contents of each package shall bear marking that can be readily identified from the package list and packing shall provide complete protection from moisture, termites and mechanical shocks etc.

1.5.8 Any material found short inside the packing cases shall be supplied by the Bidder without any extra cost.

1.5.9 Notwithstanding anything stated in this clause the Bidder shall be entirely responsible for any loss, damage or depreciation to the stores.

1.6 TECHNICAL QUALIFYING REQUIREMENT

Bidder/ Sub-vendor should have manufactured and supplied at least a total of four hundred & fifty (450) nos. draw out type Air Circuit Breaker Panels and / or draw out Motor Control Centre Panels complete in all respects with fault rating of at least 50kA for 1 sec. and 105kA (peak) under a single order and these panels should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening (**i.e. 02.11.2015**).

Bidder/ Sub-vendor should have manufactured and supplied at least one hundred & fifty (150) nos. of draw out Circuit Breaker Panels with Air Circuit Breakers having fault rating of at least 50kA for 1 second, 105kA MAKING and 50kA BREAKING, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening (**i.e. 02.11.2015**).

Note:

Each Single Front Panel shall be counted as one (1) Panel, Double Front Panel as one (1) Panel and Air Circuit Breaker Panel as one (1) Vertical Panel.

1.7 ATTACHMENT – 3K

Documents supporting provenness criteria (as mentioned in clause 1.6 above) shall be submitted along with the offer. Bidder shall submit duly signed & stamped format (Attachment-3K, enclosed as Annexure-2).

Offers submitted without attachment-3K shall be liable for rejection.

1.8 MANUFACTURING QUALITY PLAN

Manufacturer shall follow UPRVUNL/ NTPC Manufacturing Quality Plan (Annexure-3).

1.9 SUBMISSION & APPROVAL OF DOCUMENTS

As per NTPC MDL following documents with project title block & document numbers as mentioned below are required to be submitted by bidder after award of order,

NTPC Doc. No.	Document Description
9962-001-TB-572-PVE-C-213	GENERAL NOTES FOR DISTRIBUTION BOARDS
9962-001-TB-572-PVE-C-214	ACDB - G.A. DRAWING FOR 415V AC DISTRIBUTION BOARD

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9962-001-TB-572-PVE-P-215	ACDB - SLD FOR 415V AC DISTRIBUTION BOARD
9962-001-TB-572-PVE-S-216	ACDB - SCHEME/WIRING DIAGRAM FOR 415 V AC DISTRIBUTION BOARD
9962-001-TB-572-PVE-C-217	ACDB - BILL OF MATERIALS FOR 415 V AC DISTRIBUTION BOARD
9962-001-TB-572-PVE-C-218	DCDB - G.A. DRAWING FOR 220V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-P-219	DCDB - SLD FOR 220V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-S-220	DCDB - SCHEME /WIRING DIAGRAM FOR 220V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-C-221	DCDB - BILL OF MATERIALS FOR 220 V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-C-222	DCDB - G.A. DRAWING FOR 48V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-P-223	DCDB - SLD FOR 48V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-S-224	DCDB - SCHEME/WIRING DIA FOR 48V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-C-225	DCDB - BILL OF MATERIALS FOR 48V DC DISTRIBUTION BOARD
9962-001-TB-572-PVE-Y-233	DRAWINGS & GUARANTEED TECHNICAL PARTICULARS FOR LIGHTING TRANSFORMER
9962-001-TB-572-PVE-W-226	ACDB & DCDB - TYPE TEST REPORTS
9962-001-TB-572-PVE-W-234	TYPE TEST REPORT OF LIGHTING TRANSFORMER

Any additional document not mentioned above but is required as per specification for customer approval shall also be submitted by bidder after award of order. NTPC document no. for such documents shall be provided after award of order.

Item-wise/ Board-wise technical manufacturing clearance shall be given to vendor on the basis of approval of GA, SLD, scheme drawings, GTP, TTR and BOM of that particular Distribution Board. Technical manufacturing clearance for spares shall be given only after approval of spares BOQ approval.

BILL OF QUANTITY FOR DISTRIBUTION BOARDS

S.No.	Description	Unit	Qty
A.	Main Items		
1	415V, 3Ph, 4 wire, 1000A, 50kA for 1s AC DISTRIBUTION BOARD (PMCC)	Set	1
2	415V, 3Ph, 3 wire, 250A, 50kA for 1s EMERGENCY POWER DISTRIBUTION BOARD (EPDB)	Set	1
3	415V,3ph, 4 wire, 250A, MAIN LIGHTING DISTRIBUTION BOARD (MLDB) including 2 nos. 150 kVA, 415/415V Lighting transformer	Set	1
4	415V, 3ph, 4 wire , 100A, EMERGENCY LIGHTING DISTRIBUTION BOARD (ELDB) including 1 no. 50 kVA, 415/415V Lighting transformer	Set	1
5	220V, 125A, 25kA (DC) for 1s DC DISTRIBUTION BOARD	Set	1
6	48V, 63A, 25kA (DC) for 1s DC DISTRIBUTION BOARD	Set	1
7	125A Fuse (DP) box for 220V Battery	Set	2
8	63A Fuse (DP) box for 48V Battery	Set	1
B.	Mandatory Spares*		
9	Complete pole of breaker (of each type & rating)	Nos.	1
10	Spring charging motors	Nos.	6
11	Aux. contact set	Set	12
12	Limit switches	Nos.	6
13	Arc chutes	Nos.	4
14	Fixed contact set	Set	6
15	Moving contact set	Set	6
16	Arcing contact	Set	6
17	Charging spring	Nos.	3
18	Current transformer (metering)	Nos.	3
19	Current transformer (protection)	Nos.	3
20	Closing coil	Nos.	12
21	Trip coil	Nos.	12
22	CT for Bimetal O/L relays (of each type & rating)	Nos.	1
23	Voltage transformer (of each rating)	Nos.	3
24	Control supply transformer (of each rating)	Nos.	1
25	Ammeter (of each rating & size)	Nos.	1
26	Voltmeter (of each rating & size)	Nos.	1
27	Relays (of each type & rating)	Nos.	1
28	Power contactor (of each rating)	Nos.	5
29	Coil of power contactor (of each rating)	Nos.	10
30	Air break switches (10 % of each rating)	Set	1
31	DP air break switches (DC) (of each rating)	Nos.	2
32	Control & selector switches (5% of each type and size)	Set	1
33	Control fuses & neutral links (30 % Of population for fuses,10% of population for link)	Set	1
34	Indicating lamps (20% of installed quantity)	Set	1

35	Bus bar support insulators (5% of installed quantity of each type)	Set	1
36	Bus duct flexible connectors (of each type)	Nos.	1
37	Primary disconnect in MCC(Male/ female contact set of each rating)	Set	1
38	Push buttons (10 % of each type)	Set	1
39	Power fuses (50 % of each type)	Set	1
40	Thermal bimetal relays (of each type and size)	Nos.	6
41	Indication Lamp Holders complete (20% of installed quantity)	Set	1
42	Maintenance tools and accessories for Maintenance (bidder to list)	Nos.	6
43	Terminal blocks (10% of installed quantity)	Set	1
44	Busbar aluminium flat pieces (12 meters of each size)	Set	1
45	Busbar angles/formed pieces for breaker	Nos.	1
C.	Services		
46	Supervision of Erection Testing & Commissioning.	LOT	1

NOTES:

- 1 *Technical requirements (fault rating, metering & protection requirements etc.) shall be as per enclosed SLD of Distribution Boards & UPRVUNL specification.*
- 2 ** - Quantity mentioned in percentage (%) is the % of total installed for all boards. If percentage comes as fraction next higher integer should be considered for the purpose of quantity required. For spare items of all types, ratings & sizes all boards are to be considered.*
- 3 *It will be the bidders responsibility to organise deputation of OEM of protection relays and devices. Equipment required for testing of protection relays are in Bidders scope.*

Sub-Qualifying Requirements **Data to be filled in to meet the proveness requirements**
(Refer Clause No. 5.5, 5.13,5.14 of Chapter 04, "Proveness" , Volume II. for **LT Switchgears, DC Batteries and Battery Charger**

- S.No. Item Description

-

LT SWITCHGEAR

- 1.1 No. of Air circuit breaker panels and/or draw out motor control centre panels manufactured and supplied complete in all respects, under a single order, with fault rating of at least 45 kA (rms) for 1 sec and 105 kA (peak) which are in successful operation for a period of not less than two years prior to the date of Techno-Commercial bid opening.
- 1.2 No. of draw out circuit breaker panels with Air circuit breakers manufactured and supplied having fault rating of at least 45kA for 1 second, 105kA MAKING and 45 kA BREAKING which are in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening

Signature of authorized signatory.....

- S.No.	Item Description
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-
- Note :**
- 1) Certificates from the client for the successful operation for each of the above shall be Submitted.
 - 2) Supporting documents/ reference data as applicable shall be submitted.

Date : (Signature).....

Place : (Printed Name).....

(Designation).....

(Common seal).....

Signature of authorized signatory.....

LT SWITCHGEAR (MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)														
ATTRIBUTES, CHARACTERISTICS ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test	All Routine tests as per IS
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				Y
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							
Fuse (IS 13703)	Y	Y				Y	Y			Y				
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				Y
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				Y
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y		Y	Y	Y	
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2. Makes of all major Bought Out Items will be subject to Owner/ Owner Engineer approval.														

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SECTION - 2

EQUIPMENT SPECIFICATION

A. CHAPTER 15A: 415V SWITCHGEARS, NON SEGREGATED PHASE BUSDUCT AND DC BOARDS

Refer enclosed UPRVUNL specification Chapter 15A (28 pages) for LT Switchgear & DC Boards.

1. Following important points regarding scope of bidder for LT Switchgear & DC Boards may be noted:

- a) The main 415V Switchgear for Switchyard (PMCC as per SLD) & Emergency Switchgear shall be suitable for cable connections on both incoming & outgoing feeders side.
- b) Bus duct connection as mentioned in the enclosed UPRVUNL specification shall not be applicable for Switchyard switchgears.
- c) Switchyard PMCC, EPDB, 220V DCDB & 48V DCDB shall be of floor/ trench mounted, double front construction. Modules shall be fixed or draw-out type as per the SLD attached with Section-1.
- d) The 415 Volt System will be solidly grounded with REF and SEF protections. The 220 V DC systems will be ungrounded. The 48V system shall be positively grounded.

2. Wherever asked for in the specification/ SLD in Section-1, MEAA class meters & metering shall meet following minimum requirements:

- a) Energy accounting and audit meters shall be installed at such locations so as to facilitate to account for the energy generated as per CEA regulations, 2006 and its amendments as on 4th June 2010 and Accuracy class of MEAA Meter and its associated CTs shall be as mentioned below:
 - i. On LV side incoming transformer feeders of 415V buses and incoming feeder of emergency MCC bus from DG PCC – Accuracy Class – 0.5S.
 - ii. Voltage measured on each bus. Current measured on each feeder. Motor feeder rated above 30 kW shall be provided with ammeter in module door.
- b) Even in numerical relays having built in features of energy measurement of requisite accuracy are provided in switchgear, separate energy meter has to be provided. The accuracy class of CTs and VTs shall not be inferior to that of associated meters.
- c) The energy accounting and audit meters shall be suitable for measurement, recording and display of cumulative active energy with date and time.

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- d) The energy accounting and audit meters may also have the facility to measure, record and display one or more of the following parameters depending upon the energy accounting and audit requirement. All parameters excluding instantaneous electrical parameters shall also be stored in memory.
 - i) Apparent power
 - ii) Phase wise kilowatt at peak kVA
 - iii) Phase wise kVA (reactive) at peak kVA
 - iv) Phase wise voltage at peak kVA
 - v) Power down time
 - vi) Average power factor
 - vii) Line currents
 - viii) Phase voltages
 - ix) Date and time
 - x) Tamper events
- e) The energy accounting and audit meter shall have storage capacity for at least 35 days in a non-volatile memory. Energy accounting and audit meters shall have facility to download the parameters through meter reading instruments as well as remote transmission of data over communication network.
- f) Energy meters shall be electronic digital integrated type with built in test facilities. Alternatively, they may have test block to facilitate testing of meter without disturbing C.T or V.T secondary connections. The necessary transducers shall also be supplied along with watt-hour meter. The transducers shall be mounted in the switchgear panel itself.
- g) Transducers shall be provided for conversion of AC electrical quantities such as voltage, current and power. Transducers shall be of low burden type having 4-20 mA DC linear galvanically isolated output compatible with secondary indicating instrument. Transducer shall be dual channel type. Transducers shall be suitable for 220V DC auxiliary supply.

3. In general, minimum accuracy class (until specified otherwise) shall be as per below:

- a) Current transformer
 - i) Class PS for differential relaying
 - ii) Class 5P20 for other relaying
 - iii) Class 0.2S and ISF <5 for energy accounting and audit metering
 - iv) Class 1.0 for metering
- b) Voltage transformer
 - i) Class 0.2 for metering
 - ii) Class 3P for protection
 - iii) Class 0.2 for energy accounting and audit metering

4. The minimum protections (until specified otherwise) to be provided are listed below:

4.1 For different types of Breaker controlled circuits,

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a)	Incoming feeder	:	O/C relays (50/51) for phase fault with timer (2) O/C relay (50N/51N) for Earth fault with timer (2) Under voltage relay (27) with timers.
b)	Lighting transformer feeder	:	3 pole inverse time O/C relays with high set instantaneous units for phase fault (50/51) 1 instantaneous O/C relay for earth fault (50N).
c)	Outgoing feeder	:	2 pole inverse time O/C relays (51) for phase fault. 1 pole Inverse time O/C relay (51N) for earth fault.

- d) All inverse time O/C relays shall be 1.3 sec. Version.
- e) Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip coil supervision (74) relays. Lockout relay shall be hand reset type.
- f) Fuse failure circuit shall be provided on the secondary side of voltage transformer to monitor H.V. & L.V. fuses and to prevent wrong tripping of breakers from U/V relay during fuse failure.
- g) Under voltage protection is to be provided on all L.V. breaker controlled motors. The under voltage protection shall be connected on bus VT and shall trip all motors connected on the bus after a time delay.

4.2 For different types 415V MCC & DB ,

a)	Incoming feeder	:	O/C relays (50/51) for phase fault with timer (2) O/C relay (50N/51N) for Earth fault with timer (2) Under voltage relay (27) with timer.
b)	Outgoing motor feeder	:	O/C relays (50/51) for phase fault with timer (2) O/C relay (50N/51N) for Earth fault with timer (2)
c)	Switch fuse feeders	:	HRC Fuse protected

- d) Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86), lockout supervision (95) and trip coil supervision (74) relays. Lockout relay shall be hand reset type.
- e) Fuse monitoring relay (98) shall be provided on the secondary side of voltage transformer to monitor fuses.

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B. CHAPTER 27: ILLUMINATION SYSTEM (FOR MLDB & ELDB)

Refer enclosed UPRVUNL specification Chapter 27 (3 pages) - Illumination System for Main Lighting & Emergency Lighting Distribution Boards (including Lighting Transformers).

1. Following important points regarding scope of bidder for MLDB & ELDB may be noted:

- a) Bidder's scope is to supply MLDB & ELDB (including Lighting Transformers) as per the details given in the enclosed UPRVUNL specification & SLD in Section-1.
- b) Both MLDB & ELDB shall be of floor/ trench mounted single front, fixed type construction.

2. Lighting Transformers for MLDB & ELDB:

Lighting transformers shall be dry type, indoor type dusty vermin proof having 415 V/415 V $\pm$ 2 x 2.5% with off load tap-changer on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.). Rating of each lighting transformer shall be as per the enclosed SLD in Section-1 of this specification. The casing of the transformer shall be grounded at least at two (2) points.

3. Construction & Equipment of MLDB & ELDB:

- a) Lighting Distribution Boards shall be metal-enclosed, cabinet type, fabricated, fixed type from CRCA sheet steel minimum 2.5 mm thick for load bearing members and 2.0 mm for non-load bearing members, suitable for either wall/column mounting on brackets or floor mounting on channel sills.
- b) Lighting Distribution Boards shall be dust and vermin-proof, IP-54 or better. The cubicle housing transformer shall be minimum IP-42.
- c) Lighting Distribution Boards shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements. The LDB shall be fixed on a bottom channel 75mm.
- d) Lighting Distribution Boards shall have provision of cable entry from bottom with removable gland plates.
- e) Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board for connection to ground conductor.
- f) Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc.

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- g) Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85°C. Minimum size shall be 25 x 6 mm. The current density of Aluminium bus bar should not be below 0.8 Amp/Sq.mm. The bus bar shall be provided with heat-shrunk/cold-shrunk PVC sleeve.
- h) Board shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase busbars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker is available on the front.
- i) Incoming and outgoing circuits shall be terminated in suitable terminal blocks.
- j) Each board shall consist of one dry type transformer housed in the different cubicles one (1) V.T operated voltmeter with selector switch, one (1) C.T operated ammeter selector switch, VTs, CTs, three (3) nos. phase energized indication lamps backed up by fuses and incoming triple pole MCCB. Proper discrimination between outgoing MCCB of lighting distribution board and downstream MCCB of lighting panel shall be ensured.
- k) Each lighting panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB).
- l) Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.
- m) All MCCB shall be single throw, air break and heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type.
- n) Contactors shall be air-break electromagnetic type. Push buttons shall be push to actuate type.
- o) MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.
- p) Voltmeter / Ammeter shall be of accuracy class 2.0 or better as per IS: 1248. Voltmeter / Ammeter selector switch shall be of reputed make.

PROJECT: 400kV Switchyard for Panki Thermal Power Station (1x660MW)

CUSTOMER: UPRVUNL

REVIEW CONSULTANT: NTPC LTD.

CONSULTANT: DCPL

Technical Specification of AC & DC Distribution Boards

TB-316-401-010

Section-2: Equipment Specification

REV.00

C. AC & DC FUSE BOARDS

1. Constructional details

- a) All fuse boards shall be metal enclosed, fixed type, non-compartmentalized construction, suitable for indoor/ outdoor mounting on wall or steel structure.
- b) The fuse board frame shall be fabricated using suitable mild steel structures or pressed and shaped cold rolled sheet steel of thickness not less than 2.0 mm. The frames shall be enclosed by cold rolled sheet steel of thickness not less than 1.6 mm.
- c) The fuse boards shall be provided with doors on the front. The doors shall preferably be in two halves with hinges at the extreme ends and locking facility at the centre.
- d) Suitable EPDM/Neoprene gaskets shall be provided to make fuse boards completely dust and vermin-proof with a degree of protection of IP-52 for indoor and IP-54 for outdoor application, as per IS/IEC 60947.
- e) The fuses shall be mounted in an insulating fuse carrier and it shall be possible to replace the outgoing feeder fuses without disturbing the other feeders. The handle of incoming switch shall be mounted on the door of the fuse board, with padlocking facility in both 'ON' and 'OFF' positions. The outgoing feeder switches shall preferably be of rotary type.
- f) Cable entry facilities shall be provided at top / bottom with removable gland plates of suitable thickness. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

CHAPTER 15A : 415V SWITCHGEARS, NON SEGREGATED PHASE BUSDUCT AND DC BOARDS**1.01.00 SCOPE**

1.01.01 This specification is intended to cover design, engineering, manufacture, assembly, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of following with all fittings and accessories for efficient & trouble free operation

1. 415 V Power control Centre (PCC)
2. ~~415 V Motor Control Centers (MCC)~~
3. 415 V Motor cum Power control centre (PMCC)
4. 415 V Distribution Boards (DB) and Fuse boards

5. **DELETED**

6.

7.

8.

1.01.02 Base channel frame of all boards and fuse boards along with necessary mounting hardware.

Base channel shall be provided by BHEL, however any foundation bolts for fixing on trench mounted channels or for wall mounting shall be provided by vendor.

1. Set of accessories as listed below:
2. Breaker lifting & handling trolley
3. Racking in/out handle for breakers
4. Racking in/out handle for drawout MCC modules

1.01.03 20% spare outgoing feeders with atleast one of each type and rating shall be provided in each switchgear.

1.01.03 Mandatory Spares

1.01.04 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, ~~crimp type tinned copper/aluminium lugs, double compression type brass glands with tapered washer (power cables only)~~ and terminal blocks.

1.01.05 Foundation bolts for all the floor mounted equipment, and fixing bolts and accessories for wall mounted equipment.

1.01.06 All interconnecting wiring between various panels/compartments of a switchgear or MCC shall be carried out internally by the Contractor at his works/site.

1.01.07 Certain switchgears with very long lengths shall be sectionalized and physically separated for ease of operation and maintenance. Interconnection of such sections by bus trunking shall be in Bidder's scope.

1.01.08 Bidder shall supply dummy panels, if required for floor beam crossing without any price implication.

1.01.09 415V Switchgears shall have Air Break Spring Charged D.C. Motor operated stored energy type Circuit Breakers with integral manual spring charging



handle for Incoming and Tie feeders. These Breakers shall be electrically operated type, and shall be provided with electrical and mechanical interlocks to prevent paralleling of two different sources of supply.

1.01.10

For single/ double
front construction,
refer SLD in
Section-1.

All MCCs/Switchgears shall be of single/double front construction. All Switchgears/MCCs shall be sectionalized, and Breakers shall be provided for Incoming and Bus Section feeders as specified. These shall be electrically interlocked (if Incomers are through breakers) and castel-key interlocked (if Incomers are through load break Switch/fuse-switch unit). But provision shall be made to defeat interlock to enable parallel operation in case of emergency.

1.01.11

All Switchgears shall be easily extendable on either side. The Bidder shall supply Switchgear in various shipping sections consisting of Incomer, Ties and Motor modules. Bidder may be required to change module types, sizes and the components in respect of certain feeders even during erection, testing and commissioning.

1.01.12

The Bidder shall furnish calculations and/or type-test certificates prove adequacy of the busbar sizes offered, for specified current and short time current ratings. Bus bars in particular and droppers (HBB/VBB) shall be supported on SMC/DMC/FRP supports and covered with heat-shrunk PVC sleeves which shall be shrunk fit and not capable of being removed without destruction. While continuous current ratings of the droppers in each Switchgear Cubicle shall be at least equal to the corresponding Breaker rating, short time current rating shall be same as that for Horizontal Main Bus bars. Only those dropper ratings will be allowed as have passed a type test.

1.01.13

All fuses, switches, fuse switch combinations, contactors and overload relays shall conform to Type-II class of Co-ordination as per IS-13947. Bidder shall furnish Type-II Co-ordination, p & q type test report as per IS: 13947 for all modules along with Bid. Moreover rating of switch shall be at least same or more than that of associated fuse in all cases. The bidder shall have to carryout the 'p', 'q' test as per IS: 13947 before the supply of equipment at Central Power Research Institute.

1.01.14

The Contractor shall furnish relay application checks/ calculations to check adequacy of the CTs/VTs as well as suitability of relay settings/setting ranges proposed by the Bidder. These checks/ calculations shall be furnished during detailed engineering stage for each and every feeder.

1.01.15

~~LT Switchgear for stacker reclaimer shall be fixed type and no spare shall be provided.~~

2.00.00 Auto Changeover

2.01.00

Auto-changeover facility will be provided in PCC and MCCs as required during detailed Engineering. These Switchgears/MCC will normally operate with Buscoupler open. If sustained under voltage is detected on any one of the bus section, the respective Incoming Breaker shall trip and bus - coupler shall close if voltage is available on the other bus section. Auto changeover shall be blocked if the Incoming Breaker has tripped due to bus fault. Manual change over from one source of supply to the other or vice versa shall be possible by momentary paralleling of the two supplies after checking synchronism with the help of a synchro check relay. On closing the Incoming breaker, the running Breaker should trip within a preset time. An annunciation shall be provided if the two bus sections remains paralleled for more than a preset time. If the



running breaker fails to trip within the preset time the incoming breaker shall trip. All necessary voltage/isolating transformer; synchrocheck relay etc. shall be supplied for this.

- 2.02.00 Emergency switchgear will normally have the four incomers one from Unit PMCC, which is normally closed and second from Misc. PMCC, third from DG Set-1 and fourth from standby DG without any bus coupler. In case of sustained under voltage on already closed first incomer, the same will trip and the second incomer will close automatically after a preset time delay. In case the second incomer also trips due to sustained under voltage; automatic starting signal will be given to DIESEL GENERATOR. After DG has run upto rated speed and voltage is built up, the DG breaker shall be automatically closed. In case the main DG fails to start than command shall be given to the standby DG Set. After the standby DG has run upto rated speed and voltage is built up the standby DG breaker shall be automatically closed. Auto changeover on Emergency PCC shall be blocked if lockout trip relay of any incomer is energized due to fault. Changeover from one source to the other will be manually accomplished by first tripping the running source and then closing the breaker of incoming source. Only reputed make auxiliary relays are to be used for status changeover of contacts used in control circuit, auxiliary contactors are not acceptable.

REFER SLD in Section-1
for Switchyard EPDB for
incomers arrangement.

3.00.00 GENERAL

3.01.00 POWER CONTROL CENTER (PCC)

- 3.01.01 POWER CONTROL CENTER hereinafter referred to as PCC, shall mean a continuous line-up of breaker panels, used to feed Motor Control Centres. All PCCs shall have duplicate incomers and a bus-section. Incomers, bus- section, and all outgoing feeder of a PCC shall be breaker controlled & SFU. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PCC.
- 3.01.02 MOTOR CONTROL CENTER, hereinafter referred to as MCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, contactor operated modules. All incomers and Bus-sections shall be breaker controlled except few, which are castle key inter-locked. Whenever bus-sections are provided, all outgoing feeders shall be breaker/switch fuse controlled, or contactor operated depending upon the rating and application. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the MCC.
- 3.01.03 POWER-CUM-MOTOR CONTROL CENTER, hereinafter referred to as PMCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, and contactor-operated modules. All PMCCs shall have duplicate incomers and a bus-section. Incomers and bus-sections shall be breaker controlled. Depending upon the rating and application, outgoing feeders may be breaker controlled, switch fuse controlled, or contactor operated. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PMCC.
- 3.01.04 DISTRIBUTION BOARD, hereinafter referred to as DB, shall mean a continuous line-up of vertical sections housing switch fuse modules only. ACDBs shall have duplicate incomers and a bus-section. Powerhouse main DCDBs shall have two incomers from its associated battery charger with bus sectionaliser. Wherever bus-sections are provided, distribution of outgoing feeders shall be



such as to ensure uniform loading on each section of DB. Two(2) nos Floor wise DC sub DB shall be provided having single Incomer from Each Bus section of main DCDB to cater supply for HT/LT switchgear and Transformer auxiliary supply as source 1 & source 2. Valve DBs shall be provided on floor wise/area wise of boiler and turbine side to cater valve load and will be wall mounted fed from respective boiler/turbine MCC. Valve DBs shall have single incomer only.

3.01.05 SOLENOID VALVE BOARD, hereinafter referred to as SVB, shall mean a continuous line-up of vertical sections housing switch-fuse modules and contactor -operated modules. SVBs may have one incomer, which shall be switch fuse controlled. All outgoing feeders shall be contactor operated. FUSE BOARD, hereinafter referred to as FB, shall mean a continuous line-up of vertical sections housing switch fuse only. FBs Boards may be fed from DBs and may have one incomer.

3.01.06 AC fuse boards shall consist of:

- 1 no. 63A TPN SFU as incomer with lamps and meters.
- 9 nos. 16A SPN SFU & 3 nos 16A TPN SFU as outgoing.

3.01.07 DC fuse boards shall consist of:

- 1 no. 63A switch as incomer with meters, lamps and auxiliary contactors.
- 8 nos outgoing feeders with 16A HRC fuses.

3.01.08 The 110 V supply for HT panel & Motors Space Heater, wherever required shall be derived through 415V/110V isolation transformer.

4.00.00 CODES AND STANDARDS

4.00.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard (IS) except where modified and / or supplemented by this specification. Indian Standards for the equipment covered under this specification are as follows:

- | | | |
|---------|---|---|
| IS:8623 | : | Specification for factory built assemblies of switchgear & control gear for voltages upto and including 1000V AC/1200 V DC. |
| IS:4237 | : | General requirements for switchgear and control gear for voltages not exceeding 1000V, |
| IS:2147 | : | Degree of protection provided by enclosures for low voltage switchgear and control gear. |
| IS:3202 | : | Code of practice for climate proofing of electrical equipment. |
| IS:3072 | : | Code of practice for installation and maintenance of Switchgear. |
| IS:8544 | : | A.C. Motor starters of voltage not exceeding 1000 V. |
| IS:2516 | : | A.C. Circuit Breakers. |

- IS:4064 : Air-breaker switches, air break disconnectors, air break disconnector and fuse combination units for voltage not exceeding 1000V AC or 1200V DC.
- IS:2705 : Current transformers
- IS:3156 : Voltage transformers
- IS:3231 : Electrical relays for power system protection.
- IS:1248 : Electrical Indicating instruments.
- IS:722 : AC Electricity Meters.
- IS:375 : Marking and arrangements of bus bars.
- IS:2208 : HRC Cartridge Fuses.
& IS:9224
(Part-II)}
- IS:2959 : Contactors
- IS:6875 : Switches and push buttons.
- IS:6005 : Code of practice of phosphating iron and steel.
- IS:5082 : Wrought Aluminium and aluminium alloys for electrical purposes.
- IS:2629 : Hot dip galvanising.
- IS:13947 : Low voltage switchgear and Control Gear.
- 4.00.02 Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such cases copies of the English version of the standard adopted shall be submitted alongwith the bid.
- 4.00.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS codes of practice. In addition, other rules or regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.
- 5.00.00 DESIGN CRITERIA**
- 5.01.00 The SWGR/PCC/MCC/BUSDUCT and DBs will be used to supply auxiliary power for normal and start-up operation, control and protection for 415/230V AC and 220V DC auxiliary services of generating units.
- 5.02.00 Duty involves direct-on-line starting of large induction motors upto 160 KW and also under certain emergency conditions automatic transfer of loads from one source of supply to other. Motor starting current varies from 6 to 8 times full load current with maximum of 3 starts per hour.
- 5.03.00 The equipment will be located in a clean but hot, humid and tropical atmosphere, highly polluted at places with coal dust and/ or fly ash.

- 5.04.00 Circuit breaker/ switchgear shall not produce any harmful over voltage during switching off induction motors/ supply. If required, surge protective devices shall be included in the scope of supply to limit over voltage.
- 5.05.00 For continuous operation at specified ratings, the temperature rise of the various equipment shall be limited to the site permissible values stipulated in this specification.
- 5.06.00 Incomers, buscouplers & outgoings rated below 630A are to be provided with Motorised MCCB. 630A and above shall be ACB controlled .
- 5.07.00 Loads of outgoing feeders wherever applicable shall also be considered while sizing the busbars, equipments and components. All equipment and components shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents listed in the annexure without any damage or deterioration of materials.
- 5.08.00 Busbars for PCC/PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20 % margin.
- 5.09.00 Busbars of MCCs/DBs/SVBs/FB shall be sized to carry continuously the running load connected to it with a 20% margin.
- 5.10.00 In cubicle ratings of incomer and bus section breakers/switches shall be identical to the associated busbar rating.
- 5.11.00 MCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating). The rating of the incomer shall be selected considering the requirement of spares. The spare feeders shall be provided with all equipment and complete wiring similar to their respective active feeders.
- 5.12.00 The control circuitry of all modules in respective PCC/MCC shall be suitable for interfacing with plant DCS for remote monitoring switching and control.
- 6.00.00 SPECIFIC REQUIREMENTS**
- 6.01.00 Construction of SWGR/PCC/ MCC/ DBs
- 6.01.01 SWGR/PCC/MCC/DBs shall be indoor, air insulated, metal-clad, floor mounting type. All SWGRs/PCCs/MCCs shall be fully draw out type having self aligning type secondary plug in contracts. All DBs shall be fixed type. The design and construction shall be such as to allow extension at either end.
- 6.01.02 PCCs/DBs/SVBs shall be single front construction and PMCCs/MCCs shall be of double front construction. Breaker panels of PMCCs shall be of single front construction.
- 6.01.03 The enclosure of the equipment shall be dust and weather proof, conforming to a degree of protection IP-52 for ratings upto 1600A and IP-42 for ratings above 1600A. The switchboard frames shall be fabricated using suitable mild steel structural section or braced and shall be cold rolled sheet steel of thickness of not less than 2 mm. The frames shall be enclosed in cold rolled sheet steel of not less than 1.6 mm. The doors and covers shall also be of cold rolled steel of thickness not less than 1.6mm. Adequate stiffness shall be provided wherever necessary. Gland plates shall be 3.00mm. The design shall

For single/ double front arrangement & drawout/ fixed type arrangement of various swgr. & boards, please refer SLD in Section-1.



be such that specified degree of protection shall be achieved even after a breaker control module has been taken out of the panel.

- 6.01.04 SWGR/PCC/MCC/ DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multitier formation. The installations of circuit breakers, however, shall be limited to the single tier formation.
- 6.01.05 The design shall be fully compartmentalized with metal/ insulating partitions between compartments. FBs shall be non compartmentalized. The working height shall be limited within 300mm to 1900 mm. However for MCC modules minimum height shall be limited to 400mm. Switch boards shall be mounted on base frame of 100 mm height from the finished floor.
- 6.01.06 Each breaker/ control module/ switch fuse unit shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section of single front board shall have a removable back cover.
- 6.01.07 All doors and covers shall be provided with life long rubber and life long pasting neoprene gaskets. MCC module shall also be dust and vermin proof when the module is taken out from the chassis. Suitable arrangement to achieve this feature shall be provided.
- 6.01.08 All switches push buttons, lamps, indicating instruments shall be flush/ mounted on respective module compartment whereas relays and other auxiliary devices may be mounted on a separate cubicle. All meters indicating lamps and protective relays shall be visible on the door.
- 6.01.09 A full height vertical cable alley with cable supports shall be provided in each section to facilitate dressing of unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have hinged doors opening on opposite sides with respect to the module doors and removable cover at back side for access. The width of the cable chamber when viewed from front of the switchboard shall not be less than 250 mm. Base frame of 100 x 50 x 6 mm is to be supplied separately.
- 6.01.10 Breaker cubicle shall be so sized as to permit easy closing of the front access door when the breaker is pulled out to 'ISOLATED' position. The breaker can be operated both in SERVICE and TEST position with the door closed.
- 6.01.11 A horizontal wire way, extending the entire length, shall be provided at the top of each SWGR/PCC/MCC/ DB for inter panel wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.
- 6.01.12 In all the motor feeders dual output transducers shall be provided. Further all the incomers, Bus couplers and outgoing feeders shall also have dual output transducers
- 6.01.13 Local Push button stations shall be in sheet steel (2mm) or cast aluminium enclosure of weatherproof neoprene gasketed construction suitable for outdoor use without canopy conforming to IPW-55 or better. The push buttons of spring return type and stay put type shall be as per enclosed drawing. The push button shall be provide with separate terminal blocks.

- 6.01.14 Interposing relay (coupling relay) shall be provided for each feeder.
- 6.01.15 Incomers shall be provided at the ends of an assembly and bus section, wherever required, shall be provided at the middle of the assembly.
- 6.01.16 Four (4) nos. lifting lugs shall be provided for each section, two (2) nos. on either end of the section.
- 6.01.17 After isolation of the power and control circuit connections, it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.
- 6.01.18 The 250A & above feeders up to 630A shall have MCCB, MCCB shall be provided with microprocessor based inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. MCCB shall have current limiting feature. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door cannot be opened unless the MCCB is in OFF position. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlock.

6.02.00 BUS AND BUS TAPS FOR SWGR/PCC/MCC/DB

- 6.02.01 The main, tap off buses and connections shall be of high conductivity aluminium. The size for specified current ratings shall be such that maximum temp. rise at bus bar joints shall be limited to 85 Deg. C (i.e. 35 Deg., C rise over 50 Deg. C ambient).
- 6.02.02 Vertical bus bars shall be designed as per system requirement.
- 6.02.03 All bus connections shall be provided with anti-oxide grease. For all bus connections adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts. The protruding bolts of different phases/ poles shall be staggered and shall not see each other directly. Bimetallic connectors shall be furnished for connections between dissimilar metals. Alternatively the joints surfaces shall be silver plated.
- 6.02.04 Bus bars and connections shall be fully insulated for working voltage with adequate phases/ ground clearance. Insulating sleeves for bus bars and shrouds for joints shall be provided. Shrouds for bus bar joints and tapping points shall be two part click-fit type epoxy resin cast/ fiber glass moulded.
- 6.02.05 Minimum clearance of 25mm is required between phases/ poles for entire run of horizontal and vertical busbars and 19 mm between phase and earth irrespective of sleeve/ shroud provided for bus bars.
- 6.02.06 For all other components, the clearance between two live parts, a live part and earthed part, and isolating distance shall be at least 10 mm throughout.
- 6.02.07 Wherever it is not possible to maintain the above mentioned clearances, insulation shall be provided by means of barriers. All connections from busbars upto the fuses shall be fully shrouded to minimize risk of phase to phase and phase to earth faults.

- 6.02.08 Insulating shrouds for busbar joints shall be moulded type. SWGR/PCC/MCC/ DB with higher clearances shall be preferred considering dust laden environmental condition in which SWGR/PMCC/ MCC/ DB has to operate. Bus supports shall be flame retardant, track resistant non-hygroscopic type epoxy/ SMC/ DMC with high creepage surface. Separate supports shall be provided for each phase and neutral busbar
- 6.02.09 Cross section of busbar shall be uniform throughout the length of assembly. All buses and connections shall be supported and braced to withstand, the stresses due to maximum short-circuit current and also to take care of any thermal expansion.
- 6.02.10 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the ground to SWGR/PCC/ MCC/ DB assembly.
- 6.02.11 The horizontal busbar chamber shall be separate and totally enclosed. Control/ space heater buses shall be of copper and shall be extended throughout the length of the switchboard. These buses shall be supported by non-hygroscopic material and segregated from main busbar. Busbar chamber provided for control and auxiliary buses shall be segregated from main busbar chamber.
- 6.02.12 Busbar chamber provided for vertical busbar shall be segregated from cable alley chamber and outgoing terminals.
- 6.02.13 Bolted disconnect links shall be provided for DBS for all incoming and outgoing feeders for isolation of neutral, if necessary.
- 6.02.14 One metal sheet shall be provided between two adjacent vertical sections running to the full height of switchgear except for horizontal bus bar chamber. However, each shipping section shall have metal sheets at both ends.
- DBs shall be fixed type construction.
- 6.02.15 415V Non-segregated phase busduct :
- The entire bus duct shall be designed for dust, vermin and weather proofconstruction. A suitable aluminium sheet flange-protection hood shall beprovided to cover all outdoor bus duct enclosure joints to facilitate additional protection against rain water ingress. All horizontal runs of bus duct shall have a suitable sloped enclosure top to prevent retention of water for both indoor and out door portion of bus ducts. Bus duct enclosure shall have a degree of protection of IP-55.
 - The material of the conductor shall be aluminium. The bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings.
 - All steel structures required for bus duct support shall be hot dip galvanised.
 - The temperature rise of the bus bars and joints when carrying ninety percent (90%) of the rated current along the full run shall not exceed 40°C over an ambient of 50°C. The maximum temperature rise during short circuit conditions shall not exceed 200°C.

6.03.00 MCC/SVB/DB MODULES

- 6.03.01 Draw out type control module shall have self-aligning, plug in power / control disconnects. All disconnects shall be silver-plated to ensure good contacts.
- 6.03.02 The design shall be such as to permit easy withdrawal / reinsertion of the unit guide rails to ensure correct alignment & all the power contacts meet accurately every time the module is inserted.
- 6.03.03 Various module sizes should be multiples of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical busbars.
- 6.03.04 Control module shall house the control components for a circuit such as switch, fuse, contractors, relays, push buttons, lamps etc. as per requirement only the push button actuators, lens of indicating lamps, and transparent windows for meters shall be mounted on module door such that when the module is withdrawn the cubicle door shall be provided the specified degree of protection when the module door is closed. These modules shall be designed to withstand internal arc faults i.e. in the event of fault occurring in one module the arc should not spread to neighboring module and should not affect their functioning.
- 6.03.05 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.
- 6.03.06 It shall be possible to carry out routine, maintenance checks or small changes in a module without physically taking the module away from switchboard.
- 6.03.07 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the module is withdrawn. Under any circumstances it shall not be possible to access the vertical dropper accidentally and also suitable means shall be provided to avoid any phase short circuit in vertical droppers.
- 6.03.08 The module shall be dust & vermin proof even when module is completely withdrawn. Suitable means shall be provided to achieve this feature.
- 6.03.09 Draw out type control modules of same size and type shall be electrically and physically interchangeable.
- 6.03.10 Draw out control modules of PCC/MCC shall have the SERVICE, TEST & ISOLATED positions with positive indications and interlocking for each position. The doors of individual modules and the cable alley should open in opposite directions to facilitate clear view of the module when the operator is working on the cable terminals.
- 6.03.11 In service position, both power and control circuits shall be engaged. It shall not be possible to open the module door when the module is in service position.
- 6.03.12 In TEST position, the power circuits shall be disengaged but the control circuits shall be engaged. It shall be possible to close the module door when the module is in TEST position. Keeping the front access door of module in closed condition, the breaker can be placed in ISOLATED, TEST or SERVICE position from outside.

- 6.03.13 In ISOLATED position, both power and control circuits shall be disengaged.
- 6.03.14 Motor feeders of 30KW and above shall be provided with Ammeters & 75 KW and above shall be provided with Ammeter with selector switch.
- 6.03.15 For entire plant except CHP, motors rated 90kW and above till 200kW shall be ACB controlled. In CHP motors rated 90kW and above till 160 kW shall be ACB controlled. For motors 90 KW and above numerical protection relays are envisaged.. All motor feeder modules shall also be provided with local/field/Remote selector switches on the module itself.
- 6.03.16 For selection of modules please refer Cl. 6.04.00 below.

6.04.00 Circuit Breakers

- 6.04.01 Breakers shall have anti-pumping feature.
- 6.04.02 Circuit breakers shall have minimum interrupting capacity equal to the listed fault level.
- 6.04.03 Circuit breaker shall be three poles for motors and four poles for incomer, bus coupler and outgoing feeder single throw, air break type with stored energy, trip free mechanism and shunt trip.
- 6.04.04 The circuit breaker shall have short circuit and overload microprocessor based relay. The relay shall have facility of wide range current settings. The over current relay shall have family of IDMT characteristics curves to arrive at full discrimination with down stream over current relays / fuses MCCBs etc. The short circuit protection shall have adjustable time delay settings. If discrimination is not achieved with the relay, suitable external relays shall be provided for over current & short circuit protection.
- 6.04.05 One potential free contact for remote annunciation for each over current short circuit and under voltage, circuit breaker tripping.
- 6.04.06 Circuit breakers shall be draw out type, having SERVICE, TEST & ISOLATED positions with positive indication for each position.
- 6.04.07 Circuit breakers of identical rating shall be physically and electrically interchangeable.
- 6.04.08 All circuit breakers shall be of motor wound spring charged mechanism and also shall have hand operated spring charged mechanism facility.
- 6.04.09 For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close/ open operation of the circuit breaker shall be possible after failure of power supply to the motor.
- 6.04.10 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.
- 6.04.11 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.

- 6.04.12 Each breaker shall be provided with an closing and emergency manual trip, mechanical ON-OFF indicator, an operation counter and mechanism charge/discharge indicator.
- 6.04.13 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with following for interlocking purpose:-
- Position/ cell switch with 4 NO + 4 NC contacts.
 - Auxiliary switch, with 6 NO + 6 NC contacts, mounted on the stationary portion of the switchgear/ PMCC/ MCC and operated mechanically by a sliding lever from the breaker in SERVICE position.
 - Alternatively. Electrically reset latching relay may be used for the purpose. The exact requirement of contacts of position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the contractor taking into account the scheme requirement spares.
 - Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches for motor duty shall be provided with minimum 2 NO + 2 NC aux. contacts.
 - Limit / auxiliary switches shall be convertible type that is suitable for changing N.O contact to N.C. and vice-versa.
- 6.04.14 Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.
- 6.04.15 Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.
- 6.05.00 Switches**
- 6.05.01 Switches shall be double/ tripple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders. Motors duty switches shall be capable of safety making and breaking the locked rotor current of the associated motor circuit. Rotary switches shall be provided with dummy packet between the phases to ensure higher creepage distance.
- 6.05.02 The switch shall have quick-make, quick break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.
- 6.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.
- 6.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.
- 6.05.05 If two switches are specified for any MCC/ DB incomer, these switches shall be mechanically/ key interlocked so as to ensure that only one switch can be closed at a time. If bus coupler switch is provided these shall be

mechanically/ key interlocked so as to ensure that only two switch can be closed at a time.

6.05.06 Incomers for MCCs and DBs rated below 250A shall be load break isolator.

6.06.00 Fuses

Fuses shall be HRC type with operation indicator, preferably link type, with a minimum interrupting capacity equal to the listed short circuit current.

Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder, if specified, shall be chosen to provide discrimination with motor/ feeder fuses.

Isolating switches shall be of AC23A category when used in motor circuit, and AC 22A category for other applications. Fuse switch combination shall be provided wherever possible.

6.07.00 A.C. Starter

6.07.01 Contactors

- a) Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be utilization category AC-3 for ordinary and AC-4 for reversing starters. For conveyor motors, minimum rating of power contactors shall be 200% of the full load current of the motors. For other motors minimum rating of power contactors shall be 160% of full load current of motor. DC contactor shall be DC-3 utilization category.
- b) Each contactor shall be provided with two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V AC or 2A at 220V DC. The exact requirement of contacts shall be decided by the contractor taking into account the scheme requirements and spares.
- c) Reversing contacts shall be electrically and mechanically interlocked.
- d) Contactors associated with timer to achieve delayed dropout feature shall be provided for some essential auxiliaries. The timer used for this purpose shall be electronic type only.
- e) Reacceleration system to be adopted for Boiler MCC, turbine MCC and Emergency MCC contactor operated motor feeder.
- f) All the contactor, starters shall comply with the requirement of type-2 co-ordination as specified by IEC 60947-4-1.

6.07.02 Thermal overload

- a) Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings. Single

Phasing Preventor shall be provided as an inbuilt feature of the thermal overload relay.

- b) Relays shall be manual reset type with one changeover contact. Resetting of relays shall be possible with compartment door closed, with direct operated reset knob. Colour of resetting button shall be BLACK.
- c) Relays may be direct acting or C.T. operated, depending on current rating, C.T.s shall be included in the scope of supply.
- d) For all motors having long starting time, the relays shall be provided with saturable current transformer to avoid spurious tripping during starting of the motor. The current transformer will have linear characteristic upto approx. twice the setting current.

6.08.00 DC STARTER

- a) DC starters shall be complete with switch fuse units, contactors, resistors, relays, meters, push buttons, lamps, etc.
- b) Starters shall be furnished in totally enclosed floor mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2 mm.
- c) The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP 54.
- d) The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP 23.
- e) Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with SFU and thermostat control.

6.09.00 Control & Indication

6.09.01 The circuit breaker shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with following:-

- a. One (1) "STEST-LOCAL-REMOTE" selector switch stay put type with black pistol grip handle and key interlock for motor feeder breaker and one (1) "LOCAL REMOTE" selector switch stayput type with black pistol grip handle and key interlock for incoming and outgoing tie feeders.
- b. Two (2) heavy duty, oil tight, push buttons for TRIP & CLOSE.
- c. One (1) heavy duty, oil-tight, CLOSE-NEUTRAL-TRIP Switch
- d. Indicating light on front of compartment:

GREEN	-	Breaker open
RED	-	Breaker closed
AMBER	-	Trip/Trip circuit trouble
BLUE	-	Breaker Spring charged
AMBER	-	Breaker, Auto trip



WHITE	-	Trip coil healthy
WHITE	-	Breaker in test position
YELLOW	-	Breaker in service position

- e. Lamps shall be LED type with coloured dome. Lamps and lens shall be replaceable from the front. LED lamp shall be made in accordance with InP technology (Aluminum Indium Gallium Phosphide technology). The body shall be made of poly carbonate unbreakable lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All push button lamp shall be as per LED indicating lamp.
- f. One voltage operated earth fault relay (64) shall be provided across the neutral grounding resistor through voltage transformer for each PCC/MCC incomer fed from transformer directly. Relay shall have at least 2 nos. contacts; one shall be connected to shown earth fault lamp indication (window) on incomer panel and other for indication on operating console.
- g. Two(2) incomers and bus coupler shall be so interlocked that no two incomers shall operate in parallel.

6.09.02 The control module shall be connected for local remote operation. Each control module shall be equipped with the following:

6.09.03 Required nos. of push buttons as per scheme drawing.

6.09.04 Each push button shall have two (2) normally open and two (2) normally closed contact rated 10A at 240V.

6.09.05 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

6.09.06 One (1) MCC-REMOTE-LOCAL selector switch having make before break feature shall be provided for unidirectional motor feeders.

6.09.07 Lamps shall be LED type with coloured lens. Lens and lamps shall be replaceable from the front.

6.09.08 For control supply, the contractor shall provide 415/240 on load control transformers with 100% standby arrangement.

6.09.09 DCDBs shall be provided with indication to monitor healthiness of the incoming DC supplies.

6.10.00 Current Transformer

6.10.01 Current Transformers shall be epoxy cast-resin type rated 10 VA. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

6.10.02 Motor feeders rated 30 kW to below 75 kW, shall be provided with CTs for metering. Motor feeders rated 75 kW and above, separate CTs shall be provided for metering and protections. SFU rated 100 A and above for outgoing feeder shall be provided with CT and ammeter.



- 6.10.03 Accuracy class of the current transformers shall be:-
- Class PS for differential
 - Class 5P20 for other relaying
 - Class 1.0, ISF < 5 for metering other than MEAA
 - CTs for MEAA metering shall be as per Chapter-1
- 6.10.04 Separate wire shall be used for metering and protection as far as possible. Secondary wire terminals shall be made available accordingly.
- 6.10.05 Terminals with CT secondary shorting links for metering leads and TEST terminals block for C.T. secondary relay and KWH leads shall be provided.
- 6.10.06 VA Burden of CT's shall be adequate (15 VA minimum) for connection to remote metering system. Also additional terminal blocks etc. as may be required shall be provided in panels.
- 6.10.07 Feeder requiring remote metering and/or current monitoring shall be provided with current transducers with calibration for full scale reading. The output shall be 4-20 mA DC which shall correspond to the normal range.
- 6.10.08 CT secondary shall be rated 1 A for metering and protection.
- 6.11.00 Voltage Transformer**
- 6.11.01 Three nos. single phase voltage transformer shall be provided in each incoming power supply circuit with voltmeter and selector switch. Additional three nos. voltage transformers shall be provided for each bus section voltmeter and its selector switch.
- 6.11.02 Voltage transformers shall be epoxy cast resin and shall have an accuracy class of 1.0. Voltage Transformers mounted on breaker carriage is not acceptable. Voltage rating for the Transformer shall be 1.2 continuous and 1.5 for 30 second.
- 6.11.03 Voltage transformer shall capable to withstand 200% of rated voltage continuously without change in its characteristics.
- 6.11.04 High voltage windings of voltage transformer shall be protected by current limiting fuses.
- 6.11.05 Low voltage fuses, sized to prevent overload shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the MCC is energised.
- 6.11.06 VTs for MEAA metering shall be as per Chapter-1
- 6.12.00 Control Transformers**
- 6.12.01 For control supply control transformers of adequate rating (min. 5 KVA rating) with 100% standby shall be provided.
- 6.12.02 For motor space heating supply, the transformers of adequate rating (min. 2 KVA rating) with 100% standby shall be provided.

- 6.12.03 All the control transformers shall be placed in spacious compartments to have proper air circulation and keep lower temperature of transformer and its module.
- 6.12.04 All the control transformers shall be provided with selector switch, fuses, indicating lamps. Each control transformer shall feed to its control buses of respective bus section during normal operation. In case of failure of one of the control transformer, provision shall be made to tap the control supplies from other bus section control transformer by auto changeover using aux. relays contacts/switch. Bidder has to develop scheme accordingly. This logic shall be made applicable for space heating and winding heating control transformer also.
- 6.12.04 All control transformer shall conform to IS: 12021.
- 6.12.05 For unit Emergency Switchgear 2 Nos of control transformer shall be provided with auto change over scheme.
- 6.12.06 Control transformer shall have + 2.5% to + 5% tapplings in steps of 2.5
- 6.13.00 RELAYS
- a) The protective relays shall be static or numerical type. However, numerical type shall be preferred. All relays, auxiliary relays and devices shall be of reputed make and types proven for the application and shall be subject to purchaser approval. The relays and timers shall have appropriate setting ranges, accuracy, resetting ratio, transient over-reach and other characteristics to provide required sensitivity to the satisfaction of the owner.
 - b) Relays shall be suitable for efficient and reliable operation of the protection scheme. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. Control relay shall not trip the circuit breaker when relay is de-energized.
 - c) Relays shall be flush mounted on the front with connections at the rear shall be draw-out or plug-in type/ modular case with proper testing facilities. Provision shall be made for easy isolation of trip circuits for testing and maintenance.
 - d) Auxiliary relays shall be provided in the trip circuits of protections located outside the board, such as buchholz relay, temperature indicators, fire protection, etc.
 - e) Control circuits shall operate at suitable voltage of 110V AC or 220V DC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2x100% per section. However the breakers shall operate on 220V DC. The auxiliary bus bars for control supply shall be segregated from main bus bars. The control supplies shall be monitored.
 - f) Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and down stream breakers/ fuses/ MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.
 - g) In case of remote controlled breaker panels, following shall be provided.

Each feeder shall have local/ remote selector switch. Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/ remote selector switch is in local position. Tripping from remote shall be possible when breaker is in service position or selector switch is in remote position.

- h) Suitable self powered transducers as per IS : 12784 Part - I (if required) for feeding signals to panel mounted electrical meters (ammeters, voltmeters, VAR meters and watt meters etc.) and DCCMIS shall be provided. Alternatively, analog signals from numerical relays shall be directly used.
- i) The motor feeders for essential auxiliaries shall have contactors with delayed drop-out feature adjustable up to three seconds.

6.13.01 General-B

- (a) All protective relays shall be of numerical microprocessor based multifunctional type having communication facility for connection to DCS through PC via PLC console.
- (b) All relays shall conform to the requirements of IS 3231 / IEC: 60255 standards.
- (c) Vendor shall ensure availability of spare parts and maintenance support for the equipment for at least 15 years from the date of supply.
- (d) Any foreign relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum 15 years. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation

6.13.02 Technical Requirement

- (a) **Auxiliary Power Supply**
Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240 V with tolerance of $\pm 20\%$. The auxiliary power supply shall preferably be site selectable requiring no additional hardware.
- (b) **Basic Requirement and Constructional Requirement**
 - (i) Relays shall be suitable for flush mounting on the front with connections from the rear. The enclosure shall be dust tight having degree of protection minimum as IP:5X.
 - (ii) Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relay, the terminals shall be easily accessible for testing and commissioning.
 - (iii) Relay shall have self-diagnostic feature with indication of relay failure on relay front. However, while diagnostic circuit runs, it must not interfere in the main protective relay circuit and allow working of main protective circuit continuously. Relay faults (self-diagnostic) shall be communicated and annunciated to HMI.
 - (iv) Design of the relay shall be such that it must operate selectively and with proper discrimination. It must be immune to any kind of electromagnetic interference. Vendor to submit all related type test reports for the offered model along with the offer.

- (c) Display & Indication
- (i) All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable.
 - (ii) All relays shall have LED / LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65°C for contrast and legibility.
 - (iii) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.
 - (iv) The relay shall have at least 6 programmable LEDs on relay front.
- (d) Software Security
Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, setting and status and event data as read only parameters should be without password protection.
- (e) Disturbance, Event Recording & data Storage
Status, disturbance data and events shall be stored in non-volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.
- (f) Trip Circuit Supervision & Lock out function
- (i) Relay shall have built in lockout function. Lock out feature shall be self reset or hand reset and shall be software selectable.
 - (ii) For trip circuit supervision separate relay shall be provided.
- (g) Input / Output Interface, Filters and galvanic Isolation.
- (h) Relay shall have at least 4 NO contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.
- (i) Relay shall be made immune to capacitance effect due to long length cables.
 - (ii) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.
- (i) Serial Communication
- (i) Relay shall have RS 485 or FO (Fiber Optic) port for serial communication.
 - (ii) All relays should be able to communicate with DCS system. Data shall be available at the DCS on request.
 - (iii) Protocol adapted for communication to DCS should facilitate easy interface with world wide used open protocol like Modbus or IEC 13 protocols.

- 6.15.04 Each wire shall be identified, at both ends with permanent tubular type printed markers bearing wire numbers as per Contractor's wiring diagrams. Each wire shall be ferruled by plastic tube with indelible ink print at both ends having terminal block no., terminal nos., destination no, as per approved drawing.
- 6.15.05 Wire terminations shall be made with crimping type connectors with insulating sleeves. Wire shall not be spliced between terminals. Fork type lugs shall be provided for all control terminals. The lugs shall be suitable for 2.5 sq.mm stranded copper conductor. However, C.T. wiring shall be done by using circular type lugs.
- 6.15.06 For power wiring inside module copper cables are to be used.
- 6.15.07 Terminal blocks with loose wires shall be provided in each shipping section for inter panel wiring.
- 6.15.08 All control terminals shall be of 10 sq.mm size and shall be sliding type for draw out module and clip on type for fixed type module.

6.16.00 Terminal Blocks

- 6.16.01 Terminal blocks shall be 660V grade box-clamp type with marking strips, similar to ELMEX 10 sq.mm or equal. Terminals for C.T.secondary leads shall have provision for shorting or any other equivalent new technology terminal blocks after approval of owner.
- 6.16.02 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.
- 6.16.03 Terminal block shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.
- 6.16.04 Coloured terminal blocks for connection of power cables (R,Y,B phases) shall be provided.
- 6.16.05 Twisted pair 0.5sq.mm copper cable will be used for DCS/BMS/ATRS surface

6.17.00 Cable Termination

- 6.17.01 SWGR/PCC/MCC/DB shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection.
- 6.17.02 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, crimp type tinned copper/aluminium lugs, double compression type brass glands with tapered washer (power cables only) and terminal blocks. Terminating of power cables shall be shrouded to avoid accidental touch. Suitable supporting clamps shall be provided for cables to eliminate stresses on terminals.
- 6.17.03 Twisted pair 0.5 sq mm copper cable shall be used for DCS/BMS/ATRS interface.
- 6.17.04 Gland plates shall be minimum 4 mm thick for single core cable and 3mm for multi core cable. The gland plate and supporting arrangement for I/C Power cables shall be such as to prevent flow of eddy current.

- 6.17.05 Gland plates shall be easily removable type. The gland plate shall be mounted at 40/50 mm above the bottom of base frame of switch board.
- 6.17.06 Cabling area above gland plate shall be free of any earth bus, neutral bus etc. so that the total gland plate area is usable for cabling and also do not obstruct removal of gland plate.

6.18.00 Busduct Connection

Busduct connections, wherever provided, shall be furnished alongwith transition panel if required. Busduct connections shall be generally from top.

All connecting bus work shall have the same continuous rating as associated SWGR/PCC/MCC bus and shall be fully braced for the specified short circuit current.

All provisions such as matching flange and other accessories shall be furnished for connection to busduct.

All the incomers from transformer shall be connected by Bus duct.

6.19.00 Ground Bus

- i. A ground bus made of copper/GI rated to maximum fault current shall be extended to full length of the MCC/DB.
- ii. The ground bus shall be provided with two-bolt drilling with G.S. bolts and nuts at each end to receive 50x6 mm G.S.flat.
- iii. Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.
- iv. The frames of all other drawout modules shall be grounded through heavy multiple contacts at all times except when the power disconnects are separated by a safe distance.
- v. Wherever the schematic diagrams indicate a definite ground at the SWGR/PCC/ MCC a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.
- vi. C.T. and V.T. secondary neutral shall be earthed through removable links so that earth of one circuit maybe removed without disturbing others.
- vii. Door earthing shall be done by using 2.5 sq.mm stranded flexible copper conductor PVC insulated (Green colour).

6.20.00 Name Plates

Name Plates of approved design shall be furnished at each cubicle/control compartment, at the top of each MCC/DB and at each instrument and device mounted on or inside the cubicle.

The material shall be lamicaid or approved equal 3 mm thick with white engraved letters on black background.

The name plate shall be held by self-tapping screws. Name plate size shall be minimum 40 X 150 mm of 0.5mm thick for instrument/devices & 75 x 450 mm of 1mm thick for panels. The size of lettering shall be minimum 5 mm for

module/feeder designation; however, component designation letter size shall be 6 mm.

Caution notice on suitable metal plate shall be affixed at the back of each vertical panel for single front construction.

Board labels and panel Nos. shall be provided both on front and rear at two locations each if board is more than 10 meters in length.

6.21.00 Space Heaters and Plug Sockets

Each vertical section shall be provided with thermostat controlled space heater and 5A, 3 pin plug socket.

In addition, motor feeders 30 KW and above shall be wired up for feeding the motor space heater through suitably rated starter auxiliary NC contact.

Cubicle heater, Motor heater, plug socket circuit shall have individual switch fuse units.

For valve / actuator provision of space heater supply shall be provided.

6.22.00 A.C./D.C. Power Supply

The following power supplies shall be arranged to each SWGR/PCC/ MCC:

- a) For each SWGR/PCC/MCC 220V DC Double feeder power supply shall be arranged by contractor for breaker control.
- b) For control module in SWGR/PCC/MCC, 240V power supply shall be arranged by the contractor.
- c) 240V power supply for motor space heating/hand lamps shall be arranged by the contractor in MCC.
- d) Each SWGR/PCC/MCC shall be provided with group control transformer with 100% standby and on load changeover facility.

Isolating switch fuse units / MCBs shall be provided at each SWGR/PCC/MCC/DB for the AC/DC supplies.

Bus wires of adequate capacity shall be provided to distribute the AC/DC supplies to different cubicles. Isolating switch fuse units / MCBs shall be provided at each cubicle for AC/DC supplies.

AC load shall be so distributed as to present a balanced loading on three phase supply system.

6.23.00 Control

It shall be possible to control the starter/ breaker from local, near the motor or switchgear and remote - from Central Control Room(CCR) through potential free contacts from DCS or Trip-N-Close control switches from remote electrical control panel. it should be possible to inhibit starting of a motor from any position by a lockable stop push button located near the motor. all motor starters shall enable direct on line(DOL) starting of motors.

Every circuit breaker controlled module will have one close auxiliary relay (car) and one open auxiliary relay (oar) to operate in conjunction with open/close commands from dcs or sms.

Facilities shall be provided to connect field permissive contacts for interlocking. Necessary time delays associated with the schemes should be incorporated. At least twenty (20) percent spare terminals shall be provided for external interlocking.

6.24.00 Tropical Protection

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

6.25.00 Painting for SWGR/PCC/MCC/DB

All surfaces shall be subject to tank pretreatment process to produce a smooth, clean surface free of scale, grease and rust.

The SWGR/PCC/ MCC/DB and all other components shall be powdered coated RAL 7032(Siemens grey).

Sufficient quantity of touch-up paint shall be furnished for application at site.

6.26.00 Accessories

The following accessories shall be furnished alongwith the SWGR/PCC/ MCC.

- a. Breaker lifting and handling truck.
- b. Device for slow opening and closing of breaker – one per breaker.
- c. Breaker racking in /out handle – one per breaker.

6.27.00 Tests

All the equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

6.27.01 Routine Tests

- A) The tests for SWGR/PCC/MCC/DB shall include but not necessarily limited to the following:
 - a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.
 - b. All wiring and current carrying part shall be given appropriate high voltage test.
 - c. Primary current and voltage shall be applied to all instrument transformers.

- d. Routine test shall be carried out on all equipment such as circuit breakers, contactors, switch fuse, instrument transformers, relays, meters etc.

6.27.02 Type Tests:

1. General:

- a) All equipments to be supplied shall be of type tested design. The Contractor shall submit for owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
- b) In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost either at third party lab or in presence of client/owner's representative and submit the reports for approval.
- c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

2. LT Switchgear

The following type test certificates on each type & rating of LT switchgear and MCC panel shall be submitted.

- a) Short time withstand test.
- b) Temperature rise test.
- c) Class II- Protection co-ordination test for any three ratings of MCC module as selected by employer.
- d) Test sequence -1 & combined test sequence on each rating of circuit breaker mounted inside the panel.
- e) Degree of protection tests.
- f) Type test certificates for Numerical relays.

6.28.00 TEST WITNESS

Test shall be performed in presence of Owner's/ representative if so desired by the owner. The contractor shall give at least thirty(30) days advance notice of the date when tests are to be carried out.

DATASHEET FOR 415V PCC/PMCC/MCC/DBs

Sr. No.	Item	Units	
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1 x 660 MW - Panki Thermal Power Station

Bidding Doc. No. : 14A14-SPC-G-0001



1.0	<u>GENERAL</u>			
(a)	Type		Metal-clad, drawout (PCC/PMCC/MCC) Metal-clad, fixed (DB)	
(b)	Service		Indoor	
(c)	Enclosure		For ampere rating upto 1600 A- degree of protection of PCC/PMCC/MCC shall be IP-52 and above 1600 A the degree of protection will be IP-42.	
1.1	<u>SYSTEM</u>		AC	DC
(a)	Voltage	V	415V $\pm 10\%$	220V $\pm 10\%$
(b)	Phase		3-phase and neutral	-
(c)	Combined voltage and frequency variation		$\pm 10\%$ (absolute sum)	-
(d)	System grounding		Solidly grounded	ungrounded
1.2	<u>RATED CURRENT AT 50 degC AMBIENT</u>			
(a)	Busbar		*By Bidder	
(b)	Circuit breaker		*By Bidder	
(c)	Switches		16A to 400 A	
1.3	<u>SHORT CIRCUIT RATING</u>		AC	DC
(a)	Interrupting	kA	50 kA	25* kA
(b)	Short Time for 1 second	kA	50 kA	25* kA
1.4	<u>HV FOR 1 MINUTE (MIN.)</u>	kV	2.5 kV	1.5* kV
(a)	Indicative only; the actual value will be decided by the Bidder, after substantiating the same by calculation.			
1.5	<u>A.C./D.C POWER SUPPLY</u>			
(a)	Control Voltage for Circuit breaker	V	220V DC $\pm 10\%$	
(b)	Control voltage for MCC modules	V	110V AC $\pm 10\%$, 1 Ph, 50 Hz $\pm 5\%$	
(c)	Service voltage	V	110V AC $\pm 10\%$, 1 Ph, 50 Hz $\pm 5\%$	
2.0	<u>CIRCUIT BREAKER</u>			
2.1	<u>DUTY CYCLE</u>		0-3'-CO-3'-CO	
2.2	<u>BREAKING CURRENT</u>			
(a)	A.C. symmetrical	kA	50kA	
2.3	<u>MAKING CURRENT</u>	kA	105kA Peak	
2.4	<u>AUXILIARY VOLTAGE</u>			
(a)	Closing	V	220V D.C. (85-110%)	
(b)	Tripping	V	220V D.C. (70-110%)	
(c)	Spring Charging	V	220V D.C. (85-110%)	
3.0	<u>CONTACTOR DUTY</u>		AC	DC
			Class 3- Category AC-3 for unidirectional/inching duty drives	Class 1- Category DC- 2
4.0	<u>BUSBAR INSULATOR</u>		Epoxy/Eparchy	

A full page of blank graph paper. The grid consists of small squares formed by thin, light gray lines. There are 20 columns and 20 rows of squares, creating a uniform grid across the entire page. The margins are consistent on all sides.

TYPE	FUSE RATING	MODULE SIZES
AF	32	200MM
BF	63A	200 MM
CF	100 A	300 MM
DF	200 A	400 MM
EF	400A	600 MM

TYPE	MOTOR RATING	MCCBRATING	CONTACTOR RATING	MODULE SIZE
AU / AR	0-5.5 KW	32 A	16 A	400 MM
BU /BR	5.6-11 MW	32 A	32 A	400 MM
CU	11.1-29.9KW	63 A	63 A	600 MM
DU	30 -46 KW 37 – 45 kW	100 A 125 A	100 A 100 A	900 MM
EU	50 - 75 KW	200 A	160 A	900 MM
FU	75.1 -89.9 KW	200 A	185 A	900 MM

1. Fuse and thermal overload relay are to be co-ordinated with motor rating by the contractor



2. Module sizes are based on the minimum module width of 400 mm. Cable alley of 250 mm and panel depth 450 mm (single front)
3. For auxiliary building and for street lighting, bidder to provide necessary feeders in the MCC for MLDBs.
4. All rating shown are indicative only. Exact requirement will be decided by successful bidder based on proven design. Type II coordination shall be achieved during finalization of component rating.

**CHAPTER 15B : 415V SWITCHGEARS, NON SEGREGATED PHASE BUSDUCT AND DC
BOARDS****1.01.00 SCOPE**

- 1.01.01 Each set of 415V non-segregated phase bus duct will originate from 415V Switchgear Incomer panel terminals and will terminate at transformer terminals. The bus duct run shall be complete with all bends, flexible, bellows and terminal adaptor boxes, interconnection hardware etc. as required.
- 1.01.02 All supporting steel structures, fasteners and necessary hardware for complete bus-duct installation.

ANNEXURE-II

LIGHTING & LIGHTING TRANSFORMER

Sr. No.	ITEM	Unit	
1.0	AUXILIARY POWER SUPPLY		
1.1	SYSTEM VOLTAGE		
	Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources.		
1.1.1	A.C Supply		415 Volt, 3 phase, 50hz, 3 wire effectively grounded system Fault level 50kA rms symmetrical
1.1.2	DC Supply		Fault level 25kA symmetrical 220V, 2wire, ungrounded system.
1.2	PERMISSIBLE VARIATION		
	Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:		
1.2.1	A.C Supply		Voltage $\pm 10\%$ Frequency $\pm 5\%$ Combined voltage and frequency 10% (absolute sum)
1.2.2	D.C Supply		Voltage 198 to 242 Volt
3.0	LIGHITNG TRANSFORMER		
3.1	Type		Cast Resin Dry type, non-encapsulated VPI with nomex insulation
3.2	KVA rating		100kVA (Min.) Refer SLD
3.3	Voltage rating		415 V/433 V 415V/415V
3.4	Cooling		AN
3.5	P.U. Impedance		*0.04 $\pm 10\%$
3.6	Voltage control		Off load tap switch/link with change of $\pm 5\%$ in step of 2.5% tapping full capacity
3.7	Vector Group		Dyn11
3.8	Class of Insulation		F (155 Deg.C)
3.9	Maximum Temperature rise over 50 Deg C. ambient in winding by resistance		90 Deg.C
3.10	Neutral		Solidly grounded

Notes:

The secondary neutral of the transformer shall be brought out for getting a grounded four (4) wire supply. Each transformer shall be routine tested and one transformer shall be type tested in accordance with relevant standard.

The transformer shall be liable for rejection if the tolerance on the quoted values of losses, impedance, temperature rise, etc. exceeds the specified values of relevant standard.

The transformer shall be mounted inside sheet steel enclosure which shall be an integral part of Lighting Distribution Board.

ANNEXURE -III**FITTINGS AND ACCESSORIES OF LIGHTING TRANSFORMER**

Each transformer shall be equipped with fittings and accessories as listed below :

1. 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.
2. Handling and lifting lugs both for enclosure and core-coil assembly.
3. Jacking pad for core-coil assembly.
4. Inspection cover for cable and box.
5. Door handle operated safety limit switch with 1NO + 1NC contact.
6. Ground bus.
7. IP-55 junction box.
8. Rating and terminal marking plates.

Note : All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 240 V A.C.

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SECTION- 3

PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections of tender documents and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall prevail.

3.1 PROJECT DETAILS

	Particular	Details
a)	Customer	Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd.
b)	Engineer Consultant	DCPL
c)	Engineer Review Consultant/ Inspector	NTPC Ltd.
d)	Project Title	Panki Thermal Power Project (3x660 MW): 400kV Switchyard
e)	Project Location	Place: Panki District: Kanpur State: Uttar Pradesh
f)	Latitude & Longitude	North N26028'20" East E 80014'32"
g)	Nearest Railway Station	Panki
h)	Distance of project location from the Railway station	5 Km
i)	Nearest Major Town	Kanpur
j)	Distance of the town from the project site	16 Km.
k)	Nearest Highway from the project site	National Highway - 25
l)	Nearest airport	Kanpur – 25 Km Lucknow – 80 Km
m)	Nearest commercial airport	440 Km
n)		
	<u>SITE CONDITIONS</u> (for design purposes)	
a)	Design ambient temperature	50°C
b)	Maximum Relative humidity	85 %
c)	Height above mean sea level	Less than 1000 meters
d)	Pollution Severity	Heavily polluted (With Coal dust & Fly ash) and Highly Corrosive environment.
e)	Criteria for Wind Resistant design of structures and equipment	Standard Applicable - IS 875 (Part 3) 1987
f)	Basic Wind speed “Vb” at ten meters above the mean ground level.	47 m/ sec
g)	Siesmic data	Zone-III as per IS: 1893

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3.1.1 SYSTEM PARAMETERS:

Sl.No.	Parameters	400 kV
1	Highest system voltage	420 kV rms
2	Lightning Impulse voltage	±1425kVp
3	Switching impulse voltage	±1050kVp
4	Power frequency withstand for 1 min (rms)	630 kV(rms)
5	Max. fault level (1 sec.)	50 kA
6	Minimum creepage distance	13020 mm

3.1.2 AUXILIARY POWER:

Sl.No.	Nominal Connection Voltage	Variations in Voltage	Frequency	Phase	Neutral
1	415V	±10%	50 (+5% -5%)	3Phase , 4 Wire	Solidly Earthed
2	240V	±10%	50 (+5% -5%)	1 phase	Solidly Earthed

Combined variation of voltage and frequency shall be + 10%. Design fault level of 415V system shall be restricted to 50kA rms for 1 second & for 25kA for 1 sec. for 220V DC system.

The operational limits for variation of DC voltage are (+) 10% to (-) 15%.

3.1.3 The various minimum heights of the switchyard shall be as given below from plinth level:

Voltage	Equipment /1st Level	Main Bus Level	Jack Bus Level	Peak
400kV	8000mm	15000mm	23000mm	7500mm

The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or support insulators to the bottom of the equipment structure, where it rests on the foundation pad shall be 2550mm.

3.1.4 The minimum clearances for 400kV switchyard shall be as given below:

Phase to earth clearance	3500 mm
Phase to phase clearance	4200 mm
Section clearance	6500 mm

3.2 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognized that the bidders may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective

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schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

‘Make’ of brought-out items are subject to Owner/Purchaser’s approval.

The bidder shall furnish relevant details to the Owner/Purchaser for his concurrence before procurement. Makes approved by owner shall only be acceptable.

The bidder shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the bidder along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the BHEL. BHEL reserves the right to get any or all type/tests conducted/repeated.

3.3 CODES AND STANDARDS

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the more stringent of both shall prevail. All work shall be carried out as per the codes and standards listed out in the description of each equipment/item.

Indian Electricity Act and Indian Electricity Rules can be obtained from bureau of Indian Standards.

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

The supplier is required to follow local statutory regulations stipulated in the latest amended Electricity Supply Act 1948 and Indian Electricity Rules 1956 (latest), and other local rules and regulations.

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

The 400 kV system is being designed to limit the power frequency over voltage of 1.5 p.u. and the switching surge over voltage to 2.5 p.u. In 400 kV system the initial value of temporary over voltage could be 2.0 p.u. for 1-2 cycles. All the equipment/materials covered in this specification shall perform all its function satisfactorily without undue strain, restrike etc. under such over voltage conditions. All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation. All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like

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wind load, temperature variation, ice & snow, (not applicable for this project) short circuit etc for the equipment .

The equipment shall also comply with the following:

- a) All equipments shall be suitable for hot line washing.
- b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
- c) Piping, if any, between equipment control cabinet or operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.
- d) All equipment shall be supplied with necessary inter-pole cabling, and its cost shall be included in the cost of equipment.

3.5 ENGINEERING DATA

3.5.1 Drawings

All drawings submitted by the supplier including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. The dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

After the approval of the drawings, further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the purchaser will cover only general conformance of the data to the specification and documents, interfaces with the equipment provided under specification, external connections and of the dimensions which might affect plan layout. This review by the purchaser may not indicate a thorough review of the dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the purchaser shall not be considered by the contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

All engineering data submitted by the contractor after final process including review and approval by the purchaser shall form part of the contract document and the entire work performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the purchaser in writing.

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3.5.2 Approval Procedure

The following procedure for submission and review/approval of the drawings, data, reports, information, etc. shall be followed by Contractor:

- a. All data/information furnished by Vendor in the form of drawings, documents, Catalogues or in any other form for NTPC's information/interface and/or review and approval are referred by the general term "drawings".
- b. The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.
- c. All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.
- d. Contractor shall submit all the drawings in five (5) copies for review of Employer. Employer shall forward their comments within four (4) weeks of receipt of drawings.
- e. Upon review of each drawings, depending on the correctness and completeness of the drawings, the same will be categorised and approval accorded in one of the following categories:

CATEGORY I	Approved
CATEGORY II	Approved subject to incorporation of comments/modification as noted. Resubmit revised drawing incorporating the comments
CATEGORY III	Not approved. Resubmit revised drawings for Approval after incorporating comments/modifications as noted
CATEGORY IV	For information and records

- f. Contractor shall resubmit the drawings approved under Category II, III within one (1) week of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision number enclosed in a triangle (e.g 1.2.3. etc.).
- g. In case Contractor does not agree with any specific comment, he shall furnish the explanation for the same to Employer consideration. In all such cases Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.
- h. It is the responsibility of the Contractor to get all the drawings approved in the Category I or IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.
- i. Contractor shall not make any changes in the portion of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawings identifying the changes (along with reasons for changes) for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**
- j. Approval of drawings will not in any way relieve the Contractor of his obligations of furnishing the equipment in accordance with the specification and shall not prevent subsequent rejection if such equipment is later found to be defective.

3.5.3 Erection Drawings.

- a. Contractor shall furnish erection drawings for the guidance or commencement of erection or the first shipment, whichever is earlier. These shall generally comprise of fabrication/assembly drawings, various component/part details drawing, assembly, clearance data requirements, etc.

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The drawings shall contain details of components/ equipment with identification number, match marks, bill of materials, assembly procedures etc.

- b. For all major equipment apart from above details, assembly sequence and instructions with check-lists shall be furnished in the form of erection manuals.

3.5.4 Instruction Manual

- a. The Contractor shall submit to the Employer preliminary instruction manuals for all the equipments for review. The final instructions manuals incorporating Employer's comments and complete in all respect shall be submitted at least sixty (60) days before the first shipment of the equipment. The instruction manuals shall contain full details and drawings of all the equipments, the transportation, storage, installation, testing, operation and maintenance procedures, etc. separately for each component/equipment along with log record format. These instruction manuals shall be submitted in five (5) copies for approval.
- b. If after commissioning and initial operation of the plant, the instruction manuals require any modifications/additions/changes, the same shall being corporate and the updated final instruction manuals shall be submitted.
- c. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall have sufficient details to enable the Employer to 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 erection, testing, commissioning, operation, maintenance dismantling and repair. Each manual shall also include a complete set of approved drawings together with performance/rating curves of the equipment and test certificates, wherever applicable. The contract shall not be considered completed for purpose of taking over until such instructions and drawings have been supplied to the Employer.
- d. 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 will all relevant pamphlets.
- e. 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.
- f. A collection of the manufacturer's standard leaflets will not accepted to be taken as a compliance of this clause. The manual shall be specifically compiled for the concerned project.

3.5.5 Operation & Maintenance Manuals

The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

3.5.6 As Built Drawings

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

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 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

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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 Owner's scope and submit all necessary drawings/ documents for the same.

3.5.7 Final Submission of drawings and documents:

The Contractor shall furnish the following after approval of all drawings /documents and test reports:

- a. List of drawings bearing the Employer's and Contractor's drawing number.
- b. Two (2) bound sets alongwith 4 CD-ROMs of all drawing.
- c. All documents/designs in two (2) copies as noted above.
- d. Contractor shall also furnish six (6) bound sets of all as-built drawings including the list of all as-built drawings bearing drawing numbers. The Contractor shall also furnish two (2) sets of CD-ROMs/ DVD/Portable hard disk of all as-built drawings as decided by the Employer.
- e. The Contractor shall also furnish four (4) copies of instruction/ operations & maintenance manuals (after approval) for all the equipments.

3.5.8 TEST REPORTS

Four (4) copies of preliminary test results shall be supplied for approval prior to despatch of the equipment. Bound copies of complete test results shall be furnished later, in number of copies as per attached Distribution Schedule. These shall incorporate all tests carried out on the equipment and its auxiliaries as well as characteristic curves of current transformers including reports on the official test waves, failure detection data and copies of final test oscillograms of both voltage and current with calibration.

3.6 MATERIAL /WORKMANSHIP

Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended and shall ensure satisfactory performance throughout the service life.

In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard the purchaser shall decide upon the question of similarity. When required by the specification or when required by the purchaser the contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Purchaser.

Whenever possible, all similar part of the works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the equipment supplied under the specification. Where feasible, common component units shall be employed in different pieces of

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equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

The equipment offered in the bid only shall be accepted for supply, with the minimum modifications as agreed/accepted.

3.7 TROPICAL PROTECTION

All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

Fine mesh screen of corrosion resistant material shall be furnished on all ventilating openings to prevent entry of insects.

3.8 SPACE HEATERS

The heaters shall be suitable for continuous operation at 230 V as supply voltage. On –off switch and fuse shall be provided.

One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and the air and shall consist of coiled resistance wire centered in a metal sheath and completely encased in a highly compacted powder of magnesium oxide or other material having equal heat conducting and electrical insulation properties or they shall consist of resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and the air. Alternatively, they shall consist of a resistance wire mounted into a tubular ceramic body built into an envelope of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in vitreous glaze. The surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

3.9 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistance varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

3.10 VENTILATION OPENING

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

3.11 DEGREE OF PROTECTION

Degree of protection for various enclosures as per IS: 13947 shall be as follows:

1. LT Switchgear/MCC/DBs/Fuse Boards

- | | | |
|--|---|------|
| i. Compartments and busbar chambers upto 1600A | : | IP52 |
| ii. Compartments and busbar chambers above 1600A | : | IP42 |
| iii. Switchgear located outdoor | : | IP55 |

2. Motors

- | | | |
|--------------------|---|------------------|
| i. Indoor motors | : | IP55 |
| ii. Outdoor motors | : | IP55 with canopy |

3. Transformers

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- | | | |
|---|---|------|
| i. Indoor Transformer | : | IP22 |
| ii. Cable box-indoor area | : | IP52 |
| iii. Cable box-outdoor area | : | IP54 |
| iv. Indoor kiosks and marshalling boxes | : | IP54 |
| v. Outdoor kiosks and marshalling boxes | : | IP55 |
- 4. Push Button Stations and any other kiosk/box/panel/ enclosure**
- | | | |
|---|---|------|
| i. Indoor | : | IP54 |
| ii. Outdoor | : | IP55 |
| iii. In dusty areas, e.g. conveyor galleries, transfer points, crusher house, bunker floor etc. | : | IP65 |
- 5. Junction boxes for cables/wires** : **IP55**
- 6. Outdoor lighting fixtures** : **IP55**

The degree of protection shall be in accordance with IS: 13947 (Part –I) / IEC-947 (Part-I) / IS 12063/IEC 529. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

3.12 PRESERVATIVE SHOP COATING

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

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

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

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

3.13 RATING PLATES, NAME PLATES AND LABELS

- 3.13.1 Each equipment 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 Employer.
- 3.13.2 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.
- 3.13.3 The rated current, extended current rating and rated thermal current shall be clearly indicated in the name plate in case of current transformer.
- 3.13.4 Rated voltage, voltage factor and intermediate voltage shall be clearly indicated on the nameplate in case of capacitor voltage transformer.
- 3.13.5 Each switch shall have a clear inscription identifying its function. Switches shall also have a clear inscription of each position indication.

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- 3.13.6 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.
- 3.13.7 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.

3.14 GALVANISING

- 3.14.1 The galvanised surface shall consist of a continuous film adhering to the steel. The finished surface shall be clean and smooth, and shall be free from defects like dissolved patches, base, spot, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surfaces, flaking or peeling off, etc. The presence of any of these defects shall render the material liable to rejection.
- 3.14.2 All exposed ferrous parts shall be hot dip galvanised as per IS:2629 & IS:2633, Galvanising shall be uniform, smooth continuous and free from acid spots. Should the galvanising of the sample be found defective, the entire batch of steel shall have to be re-galvanised at Contractor's cost. The amount of zinc deposit shall be not less than 610 gms. per sq.m. of surface area and in addition, the thickness of zinc at any spot shall not be less than 85 microns. The Employer reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument acceptable to Employer and reject any component which shows thickness of zinc at any location less than 85 microns. The testing on the galvanised materials shall be carried out as per IS:2633.
- 3.14.3 The amount of zinc deposit over threaded portion of the bolts, nuts and screws shall not be less than 300 gms. per sq. meter of surface area. The amount of zinc deposit on washers shall not be less than 340 gms. per sq. meter of surface area. The threads having extra deposit of zinc shall be removed by die cutting after the completion of galvanising. The removal of extra zinc shall be carefully done so that threads shall have minimum deposits of zinc on them as specified.

3.15 PAINTING

- 3.15.1 All surfaces to be painted including interior and exteriors of enclosures and other metal parts shall be shot or sand blasted or chemically treated to remove all rust, scale, grease and other adhering foreign matters. If not specified or approved otherwise later, colour of finishing paint shall be RAL 7032 with glossy finish except for panels which shall have matt finish. The paints used shall be epoxy-based or of suitable type to withstand the salty atmosphere prevalent in the coastal areas.
- 3.15.2 All metal parts not accessible for painting shall be made of corrosion resistant materials. All machine finished or bright surfaces shall be coated with a suitable rust preventive compound and wrapped or otherwise protected.
- 3.15.3 Paints shall be carefully selected to withstand tropical heat and extremes of weather specified herein. It shall not scale-off or crinkle or be removed by abrasion due to normal handling.
- 3.15.4 Should finished paint chip-off or crinkle during transit or installation, the Contractor shall arrange for re-painting the equipment at site at his own cost.

3.16 QUALITY ASSURANCE

The Contractor shall follow his standard procedures for quality assurance and control. This shall be in standard format indicating test witness and customer hold point shall be submitted for approval by the successful bidder. A copy of the said standard procedures shall be submitted to the Owner/Purchaser for his reference. However, Owner/Purchaser reserves the right to review the same and give his observations, if any, for compliance.

The procedures shall be in such a form as to clearly delineate the manufacturing sequence, inspection points, tests and test procedures, acceptable ranges/values, reference drawings etc.

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Test shall be performed in presence of Owner/Purchaser's representative so desired by the Owner/Purchaser. The Contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

Manufacturing and quality control procedures shall be available for audit to the Owner/Purchaser and/or its representative at the place of manufacture.

The Owner/Purchaser reserves the right to inspect the equipment at the point of manufacture and witness factory and other such tests as may be necessary to ensure conformance to the specification.

The Owner/Purchaser may inspect the Contractor's facilities prior to award of contract.

The Owner/Purchaser may witness any or all of the tests stipulated in the relevant standards and this specification.

The Owner/Purchaser may conduct surveillance of the Contractor's facilities for compliance to his standard procedures of Quality Assurance and Quality Control while work on the specified equipment is in progress.

3.17 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points, as necessary. Such programs shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA program shall be generally in line with ISO-9001/IS-14001. A quality assurance program of the contractor shall generally cover the following:

- i. His organisation structure for the management and implementation of the proposed quality assurance programme
- ii. Quality System Manual
- iii. Design Control System
- iv. Documentation Data Control System
- v. Qualification data for Bidder's key Personnel.
- vi. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- vii. System for shop manufacturing and site erection controls including process, fabrication and assembly.
- viii. Control of non-conforming items and system for corrective actions and resolution of deviations.
- ix. Inspection and test procedure both for manufacture and field activities.
- x. Control of calibration and testing of measuring testing equipments.
- xi. System for Quality Audits.
- xii. System for identification and appraisal of inspection status.
- xiii. System for authorising release of manufactured product to the Employer.
- xiv. System for handling storage and delivery.
- xv. System for maintenance of records, and
- xvi. Furnishing 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 as per format enclosed as Annexure-I.

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3.18 GENERAL REQUIREMENTS - QUALITY ASSURANCE

- 13.18.1 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.
- 13.18.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review. Once the same is finalised, hard copies shall be submitted for approval. After approval the same shall be submitted in compiled form on CD ROM.
- 13.18.3 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control Organisation, during various stages of site activities starting from receipt of materials/equipment at site.
- 13.18.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed.
- 13.18.5 These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.
- 13.18.6 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of MDCC.
- 13.18.7 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.
- 13.18.8 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer.
- 13.18.9 All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
- 13.18.10 All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
- 13.18.11 Test results or qualification tests and specimen testing shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorised representative.

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- 13.18.12 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 equipments/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.
- 13.18.13 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
- 13.18.14 No welding shall be carried out on cast iron components for repair.
- 13.18.15 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.
- 13.18.16 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American 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.
- 13.18.17 In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 50mm shall be ultrasonically tested.
- 13.18.18 The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the subcontractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified subcontractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.
- 13.18.19 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the subcontractor 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.
- 13.18.20 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub vendor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.
- 13.18.21 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractors and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipments 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.
- 13.18.22 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.
- 13.18.23 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

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- 13.18.24 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

3.19 Environmental Stress Screening

All solid state electronic system / equipment / sub assembly shall be free from infant mortile components. For establishing the compliance to this requirement, the contractor / sub – contractor should meet the following.

1. The Contractor / Sub – contractor shall furnish the established procedure being followed for eliminating infant mortile components. The procedure followed by the Contractor / Sub – contractor should be substantiated along with the statistical figures to validate the procedure being followed. The necessary details as required under this clause shall be furnished at the stage of QP finalization.
Or
2. In case the Contractor / Sub – contractor do not have any established procedure to eliminate infant mortile components then two or 10% whichever is less, most densely populated Panels shall be tested for Elevated Temperature Cycle Test as per the following procedure.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours, the ambient temperature shall be maintained at 50° C. The equipment shall be interconnected with devices and kept under energized conditions so as to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature at 50° C.

In case of any failure during the test cycle, the further course of action should be mutually discussed for demonstrating the intent of the above requirement.

Burn In Test Cycle

The test shall be conducted on all the panels fully assembled and wired including the panels having undergone the above mentioned elevated temperature test.

The period of Burn in Test Cycle shall be 120 hrs and process shall be similar to the elevated temperature test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

During the Burn in Test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components / modules shall be monitored. The temperature rise inside the cubicle should not exceed 10° C above the ambient temperature.

The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not

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been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

3.20 QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit two hard copies and two sets on CDROM of the following Quality Assurance Documents as identified in respective quality plan with tick (√) mark.

Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before dispatch. However CD-Rom may be issued not later than three weeks.

3.20.1 Typical contents of Quality Assurance Document are as below:-

- i) Quality Plan,
- ii) Material mill test reports on components as specified by the specification and approved Quality Plans.
- iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.
- iv) 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.
- v) Heat Treatment Certificate/Record (Time- temperature Chart)
- vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).
- vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.
- viii) Certificate of Conformance (COC) whoever applicable.
- ix) MDCC

3.20.2 Similarly, the contractor shall be required to submit two hard copies and two sets on CD ROM of Quality Assurance Documents (in line with above) pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

3.20.3 Before dispatch/ commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

- i) If the result of the review carried out by the Inspector of the Quality document (or applicable section) is satisfactory. The Inspector shall stamp the quality document (or applicable section) for release.
- ii) If the quality document is unsatisfactory, the Supplier shall endeavour to correct the incompleteness, thus allowing finalizing 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.
- i) If a decision is made for dispatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier

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Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the dispatch of equipment.

3.21 TRANSMISSION OF QUALITY DOCUMENTS

As a general rule, two hard copies of the quality document and Two CD ROMs shall be issued to the Employer after the delivery date for the corresponding equipment. One set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Site.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 1 month after the date of the last delivery similarly as stated above.

3.22 INSPECTION, TESTING & INSPECTION CERTIFICATE

- 3.22.1 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.
- 3.22.2 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.
- 3.22.3 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.
- 3.22.4 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.
- 3.22.5 When the factory tests have been completed at the Contractor's or subcontractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 3.22.6 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

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- 3.22.7 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.
- 3.22.8 To facilitate advance planning of inspection in addition to giving inspection notice, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.
- 3.22.9 All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by customer/consultant. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

3.23 PACKAGING & TRANSPORTATION

3.24.1 Packing, Marking and shipping

The packing and shipping shall be carried out in accordance with the standard practice of Contractor and with the following additional requirements:

- a) The equipment shall be prepared in such a manner as to protect the equipment from damage or deterioration during shipping or storage. The shipments can be exposed to heavy rains, hot sun, high humidity and sudden extreme changes of temperature. The equipment shall be packed and shipped so as to protect it from all such conditions and any other abnormal conditions, generally expected during shipping & storage. **Packing shall be done by high quality material suitable for at least 1 yr. storage at site.**
- b) The metallic containers, if any, shall be considered as the property of the Contractor and he will be allowed to remove them from site once the contents are unpacked, inspected, documented and placed in temporary storage or in final position.
- c) The equipment shall be shipped in such a manner as to facilitate unloading, handling and storage enroute and at the site. The Contractor shall provide lifting lugs and special lifting devices for proper handling and erection.
- d) The Contractor shall be liable for any damage or loss resulting due to careless, improper, poor or insufficient packing and handling.
- e) Spare parts and spare equipment shall be packed separately in containers adequate for long term storage, plainly marked "Spare Parts Only". They shall be crated individually or in kits to be used in one single renewal or overhaul operation. Other spare part kits shall not be disturbed when using one set or kit.
- f) The Contractor shall at all times protect and preserve from damage, loss, corrosion and all other forms of damage, all parts of the works.

3.24.2 Transportation

- a) The Contractor shall make a careful examination of access rail/roadways to the site in order to confirm the practical maximum transport weight and dimensions as well as a careful examination of the ports of disembarkation particularly with respect to the capacity of the cranes installed and access roads.
- b) All instruments and computer/microprocessor based equipment imported into India from overseas for the purpose of this contract shall be air freighted to the nearest possible point and further by rail/road taking due precautions as per manufacturer's recommendations.

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Employer shall have the right to decide the items that should be air freighted and Employer's decision shall be binding on Contractor.

3.24.3 Insurance

- a) The Contractor shall insure all shipments and works at his own expense for not less than the full replacement cost plus any additional cost for accelerated manufacturing of the replacement parts.
- b) Loss or the damage to equipment during shipping or transportation to the site(s) or otherwise shall not constitute groups for claims for extension in time or for extra payment.

3.24 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

- 3.24.1 The material of clamps and connectors shall be Aluminium alloy casting conforming to designation A6 of IS: 617 for connecting to equipment terminals and conductors of aluminium. In case the terminals are of copper, the same clamps/connectors shall be used with 2mm thick bimetallic liner.
- 3.24.2 The material of clamps and connectors shall be Galvanised mild steel for connecting to shield wire.
- 3.24.3 Bolts, nuts and plain washers shall be hot dip galvanised mild steel for sizes M12 and above. For sizes below M12, they shall be electro-galvanised mild steel. The spring washers shall be electro-galvanised mild steel.
- 3.24.4 All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be rounded off to meet specified corona and radio interference requirements.
- 3.24.5 They shall have same current rating as that of the connected equipment. All current carrying parts shall be at least 10 mm thick. The connectors shall be manufactured to have minimum contact resistance.
- 3.24.6 Flexible connectors, braids or laminated strips shall be made up of copper/aluminium.
- 3.24.7 Current rating and size of terminal/conductor for which connector is suitable shall be put on a suitable sticker on each component which should last atleast till erection time.

3.24.1 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS, AND DISC INSULATORS

- 3.25.1 Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5284. The support insulators shall be manufactured and tested as per IS: / IEC 168/IEC 273. The insulators shall also conform to IEC 815 as applicable.
- 3.25.2 Support insulators/ bushings/ hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- 3.25.3 Porcelain used shall be homogenous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Hollow porcelain should be in one integral piece in green & fired stage.
- 3.25.4 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burns and other similar defects.
- 3.25.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or when operating at normal rated voltage.
- 3.25.6 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall be lead to deterioration. All ferrous parts shall be hot dip galvanised.
- 3.25.7 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps, the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All

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- portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- 3.25.8 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued, porcelain parts by grinding and metal parts by machining. Insulator/ bushing design shall be such as to ensure a uniform compressive pressure on the joints.
- 3.25.9 Insulator shall also meet requirement of IEC - 815 as applicable, having alternate long & short sheds.
- 3.25 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT.**
- 3.26.1 All types of control cabinets, junction boxes, marshaling boxes, lighting panels, terminal boxes, operating mechanism boxes, Kiosks etc. shall generally conform to IS:5039, IS:8623 and IEC:439 as applicable.
- 3.26.2 Mechanism Box/ Control Cabinet/ Kiosks: A sheet steel (atleast 2.5 mm thick), dust and vermin proof M.Box/CCC/CMB shall be provided with proper lighting and thermostatically controlled space heaters. The degree of protection shall be IP 55. One dummy terminal block in between each trip wire terminal shall be provided. At least 20% spare terminals shall be provided on each panel. The gasket used shall be of neoprene rubber.
- 3.26.3 Junction Boxes: The junction boxes shall be made of minimum 2 mm thick sheet steel. Gland plates shall be removable type and made of 3 mm thick sheet steel. The boxes shall be provided with detachable cover or hinged door with captive screws. Top of the box shall be arranged to slope towards the rear of the box. The box shall be hot dip galvanised and shall be provided with suitable neoprene gaskets to achieve requisite degree of protection. Adequate spacing shall be provided to terminate the external cables. The boxes shall be suitable for mounting on various types of steel structures. The terminal blocks provided shall be of 650 V grade, rated for 10 A for control cables. Suitable numbering for terminal blocks shall be done. In case of junction box for power cable, the box shall be rated for maximum current carrying capacity. Terminal blocks shall be of one piece, Klippon RSF-1 or ELMEX CSLT-1 type with insulating barriers.
- 3.26.4 The cabinets/boxes/kiosks/panels shall be free standing or wall mounting or pedestal mounting type. They shall have hinged doors with padlocking arrangement. All doors, removable covers and plates shall be gasketed all around with neoprene gaskets.
- 3.26.5 The degree of protection of of all the outdoor boxes shall not be less than IP 55 as per IS 2147.
- 3.26.6 The cable entry shall be from bottom, for which removable gasketed cable gland plates shall be provided.
- 3.26.7 Suitable 240V, single phase, 50Hz ac heaters with thermostats controlled by switch and fuse shall be provided to maintain inside temperature 10deg. above the ambient.
- 3.26.8 The size of enclosure and the layout of equipment inside shall provide generous clearances. Each cabinet/box/kiosk/panel shall be provided with a 15A, 240V ac, 2 pole, 3 pin industrial grade receptacle with switch. For incoming supply, MCB of suitable rating shall be provided. Illumination of each compartment shall be with door operated incandescent lamp. All control switches shall be of rotary switch type.
- 3.26.9 Each cabinet/box/kiosk/panel shall be provided with two earthing pads to receive 75mmx12mm GS flat. The connection shall be bolted type with two bolts per pad. The hinged door shall be connected to body using flexible wire. The cabinets/boxes/kiosks/panels shall also be provided with danger plate, and internal wiring diagram pasted on inside of the door. The front label shall be on a 3mm thick plastic plate with white letters engraved on black background
- 3.26 TERMINAL BLOCKS**

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- 3.27.1 They shall be non-disconnecting stud type of extensible design equivalent to Elmex type CAT-M4.
- 3.27.2 The terminal blocks shall be of 650 V grade, and rated to continuously carry maximum expected current. The conducting part shall be tinned or silver plated.
- 3.27.3 They shall be of moulded, non-inflammable thermosetting plastic. The material shall not deteriorate with varied conditions of temperature and humidity. The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating plastic material. Insulating barriers shall be provided between the terminal blocks so that the barriers do not hinder the wiring operation without removing the barriers.
- 3.27.4 The terminals shall be provided with marking tags for wiring identification.
- 3.27.5 Unless otherwise required (expected current rating) or specified, terminal blocks shall be suitable for connecting the following conductors on each side:
 - All CT & VT circuits - Min. four 2.5 sq.mm. copper flexible conductor
 - AC & DC power supply -Two 16 sq.mm. Aluminium conductor
 - Other control circuits - Min. two 2.5 sq.mm. copper flexible conductor.
- 3.27.6 The terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall also be provided with short circuiting and earthing facilities.

3.27 Wiring

- 3.28.1 All wiring shall be carried out with 1100 V grade stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:
 - a) All circuits except CT circuits 2.5 sq.mm
 - b) CT circuits 4 sq. mm (minimum number of strands shall be 3 per conductor).
- 3.28.2 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.
- 3.28.3 Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires shall not fall off when the wires and shall not fall off when the wire is disconnected from terminal blocks.
- 3.28.4 All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrules purposes.
- 3.28.5 All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out. Interpole cabling for all equipment's shall be carried out by the Contractor.

3.28 CABLE GLANDS AND LUGS

- 3.29.1 Cable glands shall be Double compression type, tinned/Nicked plated (coating thickness not less than 20 microns in case of tin and 10 to 15 microns in case of nickel) brass cable glands for all power and control cables. They shall provide dust and weather proof terminations. They shall comprise of heavy duty brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and off tested quality. Required number of packing glands to close unused openings in gland plates shall also be provided.
- 3.29.2 The cable glands shall be tested as per BS: 6121. The cable glands shall also be duly tested for dust proof and weather proof termination.
- 3.29.3 Cables lugs for power cables shall be tinned copper solder less crimping type conforming to IS:8309 and 8394 suitable for aluminum or copper conductor (as applicable). Cable lugs and ferrules for control cables shall be tinned copper type. The cable lugs for control cables shall

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be provided with insulating sleeve and shall suit the type of terminals provided on the equipment. The cable lugs shall suit the type of terminals provided. The cable lugs shall be of Dowell make or equivalent.

3.29 CONDUITS, PIPES AND ACCESSORIES

- 3.30.1 The bidder shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes, etc. including all necessary sundry materials, such as tees, elbows, check nuts, bushing reduces, enlargers, wooden plugs, coupling caps, nipples, gland sealing fittings, pull boxes, etc.
- 3.30.2 Rigid conduits shall be flow-coat metal conduits of Nagarjuna Coated Tubes or equivalent make. The outer surface of the conduits shall be coated with hot-dip zinc and chromate conversion coatings. The inner surface shall have silicone epoxy ester coating for easy cable pulling. Mild steel pipes shall be hot-dip galvanised. All rigid conduits/ pipes shall be of a reputed make.
- 3.30.3 Flexible conduits shall be heat-resistant lead coated steel, water-leak, fire and rust proof, and be of PLICA make or equivalent.

3.30 AUXILIARY SWITCH

The auxiliary switch shall conform of following type tests:

- a) Electrical endurance test - A minimum of 1000 operations for 2A. D.C. with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/ visual defects/ temperature rise test.
- b) Mechanical endurance test - A minimum of 5000 operations with a subsequent checking of contact pressure test/ visual examination
- c) Heat run test on contacts
- d) IR/HV test, etc.

3.31 LAMPS AND SOCKETS

3.32.1 Lamps:

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

3.32.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

3.32.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

3.32 SWITCHES & FUSES:

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

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All control switches shall be of rotary type. Toggle/piano switches shall not be accepted.

3.33 TESTS

General

During manufacture, the Owner/Purchaser's representative(s) shall have the right to expedite and/or inspect design, materials, workmanship and progress of manufacture of the Contractor's and their Sub-Contractor's equipment and may reject defective materials considered unsuitable for the intended purpose or which do not comply with the intent of the tender specification. The Contractor, upon any such rejection by the Purchaser or his representative(s), shall replace the defective or unsuitable materials. The Contractor shall provide every reasonable inspection facility to the Purchaser's Inspector(s) or representative(s) at his own and his Sub-Contractor's works.

The Contractor shall give thirty (30) day notice of readiness for inspection of component parts and/or before final assembly and test, so that the Purchaser's representative(s) may inspect the materials and witness such tests before shipment. The Purchaser's representative(s) may, at any time, inspect and request copies of any or all test data of raw materials and finished components which shall be immediately furnished.

Material being furnished against this order shall only be shipped when factory inspection, satisfactory to the Purchaser and/or their representative(s) has been conducted. Such inspection and acceptance for shipment shall not, however, relieve the Contractor from his entire responsibility for furnishing equipment conforming to the requirement of the tender specification nor shall prejudice any claim, right or privilege which the Purchaser may have because of the use or supply of defective or unsatisfactory materials or equipment. Should the inspection be waived by the purchaser, such waiver shall not also relieve the Contractor, in any way, from his entire obligations under the Contract.

The equipment shall, at the factory or after installation, be demonstrated capable of performing satisfactorily upto the Contractor's guaranteed performance. All tests required by the tender specification including retests and inspection that may be necessary owing the failure to meet any tests specified, shall be made at the Contractor's expenses. Additional tests, as necessary, shall be made to locate such failure(s) and after determining the causes of failure(s) and rectifying it, specified tests shall be repeated to establish that the rebuilt equipment meets the tender specification requirements in every respect.

Should the equipment ultimately fail to pass the specified tests, the Purchaser will have the option to reject the unit.

Tests during Manufacture

During the manufacture of equipment, tests specified in Standard Specification(s) shall be performed on each unit in addition to any of manufacturer's standard tests and requisite number of copies of tests certificates as per Distribution Schedule shall be furnished.

Routine Tests

After completion of manufacture routine tests as specified in relevant Standards and in Standard Specification(s) shall be performed on equipment and requisite number of copies of test certificates as per Distribution Schedule shall be furnished.

All tests shall be conducted in accordance with Indian Standards in effect at the time of testing and in presence of representative(s) of the Purchaser/ Consulting Engineer.

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Tests on Associated Components

Cast epoxy resin insulators, surge absorbers, current transformers, voltage transformers, control devices and other associated components as applicable, shall be tested in accordance with the relevant Indian standards and/or Manufacturer's Standards.

Type Tests

Contractor will have to submit Type test reports for all equipment for review. The test reports shall be of same or higher rating. In case the test reports are **older than 5 years from the date of techno commercial bid opening i.e. 02.11.15** or related to equipment of lower rating then fresh type tests have to be conducted without any implication.

Site Tests

The Bidder shall indicate tests recommended to be carried out at site during installation and commissioning to ensure satisfactory performance of all the equipment supplied.

Testing Facility

The Bidder shall state in the Proposal the testing facilities available at his works. Should full capacity testing equipment be not available, the Bidder shall state the method proposed to be adopted with detailed computations and justification for adopting such a method to reliably ascertain the equipment characteristics corresponding to full capacity testing.

3.4 Enclosures:

1. ANNEXURE- I – MQP (Customer format)
2. ANNEXURE- II – QUALITY ASSURANCE FOR SWITCHYARD

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS		MANUFACTURING QUALITY PLAN				PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :								
			ITEM :		QP NO.: REV.NO: DATE: PAGE: OF....										
SL. NO	COMPONENT & OPERATIONS	CHARACTERI STICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS	
					M	C/N					M	C	N		
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	** 10.			11.	
				LEGEND: * RECORDS, IDENTIFIED WITH "TICK" (✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** M: MANUFACTURER/SUB-SUPPLIER C: SUPPLIER/NOMINATED INSPECTION AGENCY, N: THE OWNER P: PERFORM W: WITNESS AND V: VERIFICATION. AS APPROPRIATE, CHP: THE OWNER SHALL IDENTIFIED IN COLUMN "N"				 		DOC. NO.: REV..... CAT.....					
MANUFACTURER / SUB-SUPPLIER		MAIN- SUPPLIER						FOR THE OWNER USE							
SIGNATURE															
								REVIEWED BY		APPROVED BY		APPRO VAL SEAL			

E2 : SWITCHYARD

ATTRIBUTES, CHARACTERISTICS  	Make, model, Type & Rating, Test Certificate	Routine & Acceptance Test as per IS / IEC	Functional requirements as per Owner Specification
ITEM, COMPONENTS, SUB SYSTEM ASSEMBLY			
Circuit Breaker (IEC: 56)	Y	Y	Y
Interruptor & hollow insulator (IEC: 233/ IS: 5284)	Y	Y	Y
Isolator (IEC: 129 / IEC: 694)	Y	Y	Y
Current Transformer (IEC: 185)	Y	Y	Y
Capacitor Voltage Trams former (IEC: 186 / 358)	Y	Y	Y
Bus Post Insualtor (IEC: 168 / 273 / IS:2544)	Y	Y	Y
Disc,Pin & String Insualtor (IEC: 383 / IS: 731)	Y	Y	Y
Long Rod Insualtor (IEC: 433)	Y	Y	Y
Surge Arrestor (IEC: 99-4)	Y	Y	Y
Hardware fittings for Insulator (IS: 2486 / BS: 3288)	Y	Y	Y
Spacer Clamps & Connector (IS: 10162 / 5561)	Y	Y	Y
Aluminum Tube (IS: 5082 / 2673 / 2678)	Y	Y	Y
Wave Trap (IEC: 353 / IS: 8792 / 8793)	Y	Y	Y
Conductor (IS: 398-P-II)(V)	Y	Y	Y
Galvanised Steel Structures (IS: 2062/2629/4759/6745)	Y	Y	Y
Vibration Damper (IS: 9708)	Y	Y	Y
Sag Compensating Spring DIN: 2089/2096 IS: 3195 / 7906	Y	Y	Y
Control & Relay Panel	Y	Y	Y
SF6 Gas filling & evacuating plant	Y	Y	Y
SF6 Gas Leak Detector	Y	Y	Y
Leakage Current Analyser	Y	Y	Y
Nitrogen Gas Filling Device	Y	Y	Y



Protection Relays	Y	Y	Y
Event Logger	Y	Y	Y
Operation Analyser	Y	Y	Y
Disturbance Recorder	Y	Y	Y
Tariff Metering System	Y	Y	Y
Synchronising Trolley	Y	Y	Y
Relay Test Kit	Y	Y	Y
LT Switchgear /LT Panels (IEC:947 / IS:13947)	Y	Y	Y
Battery IS:1652	Y	Y	Y
Lighting Panels	Y	Y	Y
Surge Monitor	Y	Y	Y

Notes:

- 1) This is an indicative list of test/checks. The manufacture is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents during QP finalisation for all items.
- 2) All major Bought Out Items will be subject to Owner/ Owner Engineer approval.

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SECTION 4

GUARANTEED AND TECHNICAL PARTICULARS

- UPRVUNL datasheet for LT Switchgear (6 pages)

10.00.00 LV SWITCHGEAR & BUS DUCTS**S. No. Description**

1.01.00	Application	
1.02.00	Make	
1.03.00	Installation	(Indoor/Outdoor)
1.04.00	Specification and standards	
1.05.00	Degree of protection as per IS:13947	
1.05.01	Breaker/MCC cubicles	
1.05.02	Busbar chamber	
1.06.00	Design ambient temperature	(deg.C)
1.07.00	System particulars	
1.08.01		
1.08.02	Supply for motors winding/ space heating	
1.08.01	Motors upto 30 KW	(V)
1.08.02	Motors above 30 KW	(V)
1.09.00	Painting shade as per IS:5	
1.09.01	External surfaces	
1.09.02	Internal surfaces	



2.00.00	SWITCHGEAR	
2.01.00	Type	
2.02.00	Installation	
2.03.00	Rated voltage:	
2.03.01	Nominal	(KV)
2.03.02	Maximum	(KV)
2.04.00	Control supply voltage	
2.04.01	Breakers	
2.04.02	DOL starters	
2.05.00	Supply for cubicles space heating and illumination	
2.06.00	Number of phase	
2.07.00	Frequency	
2.08.00	Symmetrical short circuit withstand capacity	(KA)
2.09.00	Rated one (1) second short time current	(KA)
2.10.00	Rated dynamic current	(KA peak)
2.11.00	One (1) minute power frequency dry and wet withstand voltage	
2.11.01	Complete Switchgear	(KV)
2.11.02	Power circuit and its components	(KV)
2.11.03	Control, instrumentation and protection circuits	(KV)
2.12.00	1.2x50 microsecond impulse withstand voltage full wave of positive and negative polarities	
2.12.01	Complete Switchgear	(KV peak)
2.12.02	Power circuit and its components	(KV peak)
2.12.03	Control, instrumentation	(KV peak)



	and protection circuits	
3.00.00	SWITCHGEAR OONSTOUCTIONAL FEATURES	
3.01.00	Type and designation	
3.02.00	Type of construction	
3.03.00	Cubicle sheet metal details	
3.03.01	Cold rolled/hot rolled	(mm)
1.03.02	Thickness, structural frames and load bearing members	(mm)
3.03.03	Thickness, Front and rear	(mm)
3.03.04	Thickness, sides and top	(mm)
3.03.05	Equipment mounting plate	(mm)
3.03.06	Door with cut-out	(mm)
3.03.07	Door without cut-out	(mm)
3.03.08	Cover bolted/screwed cover	
3.03.09	With cut-out	(mm)
3.03.10	Without cut-out	(mm)
3.03.11	Insulating cover/partition plate/separator plate	(mm)
3.04.00	Dimensions of Complete Board	
3.04.01	Height	(mm)
3.04.02	Length	(mm)
3.04.03	Depth	(mm)
3.05.00	Standard height, width and depth of typical panel	
3.05.01	MCC Panel	(mm)
3.05.02	PCC Panel	(mm)
3.05.03	Distribution Board Panel	(mm)
3.06.00	Weight	
3.06.01	Each MCC vertical panel	(Kg)
3.06.02	Each DB Vertical Panel	(Kg)



3.06.03	Each PCC (Breaker Panel) Vertical Panel	
3.06.04	Each transformer (for LDB/ELDB/PDB)	
3.07.00	Size of separate mounting channel	(mm)
3.08.00	Width of cable alley	(mm)
3.09.00	Recommended dynamic load- ing for foundation design	
3.10.00	Following accessories provided	
3.10.01	Each vertical panel provided with space heater, thermostat & SPN MCB	
3.10.02	Each vertical panel provided with space heater, thermostat & SPN MCB	
3.10.03	Name plates front and rear	
3.10.04	Danger plate (wherever it is required)	
3.11.00	Type of Swgr./MCC/DB (i.e.) whether Double/Single Front	
3.12.00	Execution (i.e. whether fully drawout/semi-drawout/fixed)	
4.00.00	POWER BUS BARS AND INSULATORS	
4.01.00	Material and applicable standard	
4.02.00	Cross-sectional area per phase for different current rating alongwith calculations (attach sheet if required)	
4.02.01	Horizontal Busbar	
4.02.02	Vertical Busbar	
4.03.00	Type of Busbar (HBS & VBB) insulation [bare/Painted/Epoxy Insulated/PVC Sleeved]	
4.04.00	Minimum clearance in air	
4.04.01	Between phases	(mm)
4.04.02	Between phases to earth	(mm)



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4.05.00	Continuous current rating (for various HBB & VBB sizes)	
4.05.01	At 40 Deg.C ambient	(Deg.C)
4.05.02	At 50 Deg.C ambient	(Amp)
4.06.00	One (1) second short time current rating	(KA)
4.07.00	Dynamic current rating	(KA peak)
4.08.00	Maximum temperature rise over design ambient temperature of fifty (50) degree centigrade for continuous rating	(°C)
4.09.00	One (1) minute power freq- uency dry and wet withstand voltage	(KV)
4.10.00	Is horizontal and vertical busbar provided with heat shrinkable PVC sleeve ?	
4.11.00	All busbars joints have been shrouded properly	
4.12.00	Calculation justifying adequacy of Horizontal as well as vertical bus bar size selected furnished for following :	
4.12.01	Continuous current carrying capacity	
4.12.02	Short time current carrying capacity	
4.12.03	Short circuit dynamic force withstand capacity	
4.13.00	Calculation justifying adequacy of each size of fish plate selected for continuous as well as short time current rating furnished	
4.14.00	Busbar joints silver faced	
4.15.00	Material of the support insulators	
4.16.00	Tracking index in insulators	
4.17.00	Material of interface barriers and its characteristics	
5.00.00	AUXILIARY BUSBARS	



5.01.0	24V AC (motor winding heating)	
5.01.01	Material	
5.01.02	Size	
5.01.03	continuous current rating	
5.01.04	Is busbar provided with heat shrinkable PVC sleeve ?	
5.02.00	240V AC (for motor space heater control circuit, panels space heating panel illumination and sockets)	
5.02.01	Material	
5.02.02	Size	
5.02.03	Continuous current rating	(A)

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SECTION - 5

CHECKLIST FOR AC & DC DISTRIBUTION BOARDS

Put a tick mark on 'YES' if the specified requirement is met, or put a tick mark on 'NO' if the Specified requirement is not met and give comments in the remark column.

OR

Write '(NA)' if the information/ query/ schedule is not relevant.

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED

- a) The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.
b) The evaluation of bidder against qualifying criteria specified under clause 1.6 of Section - 1 of technical specification shall be based on the documentary proof submitted by bidder along with the offer.

Hence bidder shall ensure the completeness of their offer in this regard.

SN	Criteria	Documentary proof required	Yes/No
1	Qualifying criteria (clause 1.6 of Section 1)	Proof of supply attached	
		Proof of Successful commissioning of supplied Equipment attached	
		Performance certificate attached	
2	Attachment-3K (as per clause no. 1.7 of Section-1)	Duly signed & stamped	

S.No.	Qualifying criteria (clause 1.6 of Section I)	Documentary proof required	Yes/No
1	Bidder/ sub-vendor should have manufactured and supplied at least a total of four hundred and fifty (450) nos. draw out type Air Circuit Breaker panels and/ or draw out Motor Control Centre Panels complete in all respects with fault rating of at least 50kA for 1 sec. and 105kA (peak) under single order and these panels should have been in successful operation for a period of not less than two (2) years as on date of Techno-Commercial bid opening (02.11.2015). Bidder/ sub-vendor should have manufactured and supplied at least one hundred and fifty (150) nos. of draw out Circuit Breaker panels with Air Circuit Breakers having fault rating of at least 50kA for 1 sec., 105kA Making and 50kA Breaking, which should have been in successful operation for a period of not less than two (2) years prior to the date of Techno-Commercial bid opening (02.11.2015). Note: Each Single Front Panel shall be counted as one (1) Panel, Double Front Panel as one (1) Panel & Air Circuit Breaker Panel as one (1) Vertical Panel.	Documentary proof attached	

PROJECT: 400kV Switchyard for Panki Thermal Power Station (1x660MW)
CUSTOMER: UPRVUNL
REVIEW CONSULTANT: NTPC LTD.
CONSULTANT: DCPL

Technical Specification of AC & DC Distribution Boards
Section-5: Technical Checklist

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Technical Parameters

S. No.	Parameters	Data	Response	Remarks
1	Applicable Standards	As per 4.00.00 of Ch-15A, Section-2	Yes	
2	Type of Boards	Metal enclosed , indoor, floor mounted, compartmentalized and free standing	Yes	
3	Module type	All modules shall be fixed/ draw-out type as per SLD attached in Section-1.	Yes	
4	Ingress Protection requirement	Shall be as per clause 6.01.03 of Ch-15A, Section-2 for AC & DC DBs. As per clause no. B. 3. b) of Section-2 for MLDB & ELDB. As per clause no. C. 1. d) for DC fuse boards.	Yes	
5	Accessories	Shall be as per clause 1.01.02 of Ch-15A, Section-2	Yes	
6	DC Fuse Boards	Shall be as per clause C of Section-2	Yes	
7	Special tools & tackles	List of special tools and tackles (which are proprietary in nature) is attached	Yes	
8	Offered Boards	Bidder has quoted for the AC / DC distribution boards in line with this specification	Yes	
9	Mandatory Spares	Bidder has quoted for mandatory spares as per BOQ mentioned in Annexure-1 of Section-1.	Yes	
10	Provision for Digital & Analogue Signals for SAS/ SCADA	Provided as per SLD attached in Section-1.	Yes	
11.	Cubicle Colour finish	Powdered coated RAL 7032(Siemens grey)	Yes	
12	Type test reports	Type test reports furnished shall be in line with clause 1.3 of section-1	Yes	
13	Type test validity	If type test reports are not acceptable to UPRVUNL/ NTPC/BHEL then above tests shall be conducted by the bidder free of cost	Yes	
14	Base Frame & associated hardware for mounting of Boards	Provided	Yes	
15	Provision of spare TBs for each module	Provided	Yes	

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S.No.	Description	Confirmation of Bidder
1.	Bidder to confirm that at all drawings / schemes/ data sheets/QP/ valid type tests reports/ all relevant information shall be submitted to BHEL. Obtaining customer/ NTPC approval for the same shall be the responsibility of bidder.	YES
2.	Bidder to confirm that it will offer approved Make of the components and fitments at contract stage. In case the offered make is not approved by the customer, then alternate make shall be supplied without any commercial & delivery implications to BHEL.	YES

Date:

Signature of the authorized representative of Bidder

Company Seal