

Ref: BHE/PW/PUR/BWT6-CVL-MECH-ELE-NDCT/2123/Corg-01

Date: 12/07/2019

Page 1 of 1

To

ALL BIDDERS,

Sub: Corrigendum-01: Pre-Bid meeting, Replacement of document and Extension of last date of offer submission.

Job: CIVIL, ARCHITECTURAL, MECHANICAL, ELECTRICAL, CONTROL & INSTRUMENTATION WORKS FOR NATURAL DRAUGHT COOLING TOWER (NDCT) AT MSPGCL, 1X660 MW BHUSAWAL THERMAL POWER STATION, UNIT-06, MAHARASHTRA.

Reference:

1. **E-Tender Spec No:** BHE/PW/PUR/BWT6-CVL-MECH-ELE-NDCT/2123

Bidders kindly to take note of the following:

AA) Pre-Bid meeting:

Scheduled of 2nd pre-bid Meeting
16/07/2019 and 17/07/2019, 11:00 Hrs at BHEL PSWR Nagpur

BB) Replacement of Document:

The tender document titled as, "Volume-IE-Technical Specification and Plot Plan-Part-01 of 04" is hereby replaced in totality with the 'Annexure-A' attached with this corrigendum.

Note: The above referred document shall only form part of the tender documents.

CC) Extension of Last Date for Tender Submission:

The last date of offer submission against this tender has been re-scheduled to 30/07/2019, 15.00 hrs.

Technical Bids shall be opened on 30/07/2019 at 16.00 hrs.

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All other Terms and conditions of the Tender Specification shall remain unaltered unless expressly amended by BHEL in writing. Bidders are requested to submit as a part of their offer, a copy of this corrigendum duly Digitally countersigned by the authorized signatory as a token of Bidder's unqualified acceptance of this corrigendum.

BIDDERS MAY PLEASE NOTE THAT SUBJECT TENDER IS E-TENDER AND THE OFFER IS TO BE SUBMITTED ONLY IN E-PROCUREMENT PORTAL → www.bhel.abcpocure.com

BIDDERS WHO HAVE ALREADY SUBMITTED THEIR OFFERS PRIOR TO ISSUANCE OF THIS CORRIGENDUM IN E-TENDER PORTAL ARE REQUIRED TO RE-SUBMIT THEIR OFFER AFTER TAKING COGNIZANCE OF THIS CORRIGENDUM.

Thanking you,
Yours faithfully,

AGM (Purchase)

Enclosure: Revision-01 dated 12/07/2019 of "Volume-IE-Technical Specification and Plot Plan-Part-01 of 04" - in 572 pages as Annexure-A of this corrigendum.

E-TENDER SPECIFICATION

S. No.	E- TENDER SPECIFICATION NUMBER
01	BHE/PW/PUR/BWT6-CVL-MECH-ELE-NDCT/2123

FOR

CIVIL, ARCHITECTURAL, MECHANICAL, ELECTRICAL, CONTROL & INSTRUMENTATION WORKS FOR NATURAL DRAUGHT COOLING TOWER (NDCT) AT MSPGCL, 1X660 MW BHUSAWAL THERMAL POWER STATION, UNIT-06, MAHARASHTRA.

**Volume-IE- Technical Specifications and Plot Plan-Part-01 of 04
(Revision-01 dated 12/07/2019)**

THIS TENDER SPECIFICATION CONSISTS OF:

Notice Inviting Tender	
Volume-IA	Technical Conditions of Contract
Volume-IB	Special conditions of Contract
Volume-IC	General conditions of Contract
Volume-ID	Forms & Procedures
Volume-IE	Technical Specifications and Plot Plan
Volume II	Price Bid



Bharat Heavy Electricals Limited
(A Government of India Undertaking)
Power Sector - Western Region
345-Kingsway, Nagpur-440001

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S. No.	E- TENDER SPECIFICATION NUMBER
01	BHE/PW/PUR/BWT6-CVL-MECH-ELE-NDCT/2123

FOR

CIVIL, ARCHITECTURAL, MECHANICAL, ELECTRICAL, CONTROL & INSTRUMENTATION WORKS FOR NATURAL DRAUGHT COOLING TOWER (NDCT) AT MSPGCL, 1X660 MW BHUSAWAL THERMAL POWER STATION, UNIT-06, MAHARASHTRA.

EARNEST MONEY DEPOSIT: Refer Notice Inviting Tender

LAST DATE FOR Refer Notice Inviting Tender
TENDER SUBMISSION

THESE TENDER SPECIFICATION DOCUMENTS CONTAINING VOLUME-I AND VOLUME- II ARE ISSUED TO:

M/s.

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PLEASE NOTE:
THESE TENDER SPECS DOCUMENTS ARE NOT TRANSFERABLE.

For Bharat Heavy Electricals Limited

AGM (Purchase)

Place: Nagpur

Date:

1X660 MW BHUSAWAL THERMAL POWER PROJECT

TECHNICAL SPECIFICATION FOR NATAURAL DRAFT COOLING TOWERS (TOTAL 2 BOOKS)

BOOK 1 OF 2

Specification No. : PE-TS-415-165-N002 A



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA – 201301**

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAVAL TPS	SPEC. NO.: PE-TS-415-165-N002
		SECTION:
		SUB-SECTION:
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

COOLING TOWER TECHNICAL SPECIFICATION COMPRISES OF 2 BOOKS WITH THE FOLLOWING CONTENTS:

BOOK 1 of 2 – Mechanical Specifications

SECTION	TITLE

I	Specific Technical Requirements

IA	Specific Technical Requirements (Mechanical)

IB	Specific Technical Requirements (Elec.)

IC	Specific Technical Requirements (C&I)

ID	Data Sheet – A

II	Standard Technical Specifications

IIA	Standard Technical Specifications (Mechanical) –

IIB	Standard Technical Specifications (Elec.)

IIC	Standard Technical Specifications (C&I.) – Not Applicable

III	Documents to be submitted by Bidder

IIIA	Guarantee Schedule (To be submitted along with the Bid by all Bidders)

IIIB	Compliance Certificate (To be submitted along with the Bid by all Bidders)

BOOK 2 of 2 – Civil Specification

Part-I

Part-2

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL TPS	VOLUME : II SECTION: IA SUB-SECTION: REV. NO. 00 DATE 17.06.2019 SHEET 1 of 2
1.00	INTENT OF SPECIFICATION:	
1.01	This specification is intended to cover the vetting of thermal design undertaken by BHEL Consultant, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including all civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for 1 X 660 MW BHUSAWAL TPS including complete Electrical, C&I and Civil Works as specified and as necessary. BHEL intends to get this NDCTs package executed by qualified contractors on an item rate basis. BHEL has done the thermal sizing of the NDCTs through its design Consultant and the same is approved by the owner. The owner approved thermal design is enclosed at Section IA along with the General Arrangement Drawing. The Cement, Structural and reinforced Steels for Cooling tower are excluded from Bidder's scope as they shall be free issue by BHEL. Terms and conditions for free issue items being given along with NIT. The bidders are permitted to quote for only one of the options given below. Bids with quotes for both the options are not allowed and will be liable for rejection. <u>OPTION-1:</u> The NDCT contractor is required to own the owner approved thermal design and GA drawing such that the responsibility of cooling tower performance shall remain with the bidder in all manners. Any questions or clarifications regarding thermal design may be sought by the NDCT contractor to satisfy himself of its veracity. As the quantities for thermo-hydraulic components listed at S.Nos. 24.1 to 24.6 and 25.1 to 25.5 in the BOQ are calculated based on the area inside the NDCT at respective levels shown in the GA drawing, there will be no variation allowed in quantities of these items during execution. The NDCT contractor is required to cross check the quantities of the thermo-hydraulic components as above and inform BHEL of variations, if any before submitting his bid as the cost based on the rates quoted by him against these items will be treated as "lump sum." No variations in quantities and cost of these items will be permitted during execution. All other quantities in the BOQ will be under "item rate" with permissible variations as specified elsewhere in the tender. <u>OPTION-2:</u> If found necessary, the NDCT contractor may suggest modifications to the thermo-hydraulic components (listed at S.Nos. 24.1 to 24.6 and 25.1 to 25.5 in the BOQ) with technical reasoning/analysis/calculations to justify the measures to improve the thermal performance of the NDCT which will be guaranteed by the bidder. And as such the responsibility of cooling tower performance shall remain with the bidder in all manners. While suggesting justifiable reasons for changes as above the NDCT contractor shall abide by the following constraints. Also, the NDCT contractor shall guarantee the NDCT performance considering these constraints that are inviolable. 1) Civil Design of NDCT Shell, Shell Profile and Shell dimensions at various heights 2) Foundation of NDCT 3) Air Inlet Height 4) Basin & Internal Structure Column-Beam Grid Dimensions and Elevations 5) Water Distribution Ducts 6) Layout of CW Hot water inlet header to Cooling Tower 7) Height and Diameter of NDCT. Once the changes with justifiable reasons/analyses/calculations provided by the NDCT Contractor are accepted by BHEL/Consultant and duly incorporated, the NDCT contractor will vet the final thermal design	

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL TPS	VOLUME : II	
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	& GA of NDCT and furnish the Performance guarantee. The thermal design and GA vetted by the NDCT contractor shall be furnished to Customer for approval.		
	The NDCT contractor shall vet the thermal design as above (for the option applicable) within two weeks of award of contract, for further approval by BHEL/customer.		
	The GA drawing already approved by owner may be required to be approved again depending on changes to the thermo-hydraulic components, if any and therefore the NDCT contractor shall furnish the relevant modifications agreed to by BHEL/Consultant to these items (only) keeping the other dimensions frozen for further approval from BHEL/Customer.		
	The complete design and engineering of NDCT shall remain in the scope of BHEL's Consultant.		
	All Mechanical/Electrical/C&I drawings prepared by BHEL Consultant will be reviewed by the NDCT contractor before submission to customer for approval.		
	As the quantities for thermo-hydraulic components (listed at S.Nos. 24.1 to 24.6 and 25.1 to 25.5 in the BOQ) are going to be estimated by the NDCT contractor based on his modified arrangement, no variation in quantities of these items will be permitted during execution.		
The NDCT contractor is required to estimate the "lump sum" cost of the thermo-hydraulic components based on his modified arrangement, if any and indicate the same separately (and not against the relevant BOQ items given by BHEL at S.Nos. 24.1 to 24.6 and 25.1 to 25.5 in the BOQ). This lump sum cost shall be added to the cost of other BOQ items quoted by the NDCT contractor on item-rate basis to arrive at the total cost of evaluation.			
No change in the quantities and cost of thermo-hydraulic components shall be allowed during execution due to any reason whatsoever from that quoted during tender stage.			

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS SPECIFIC TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: I
		SUB-SECTION:
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SECTION - I

SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION IA - Specific Technical Requirements (Mech.)

SUB-SECTION IB - Specific Technical Requirements (Electrical)

SUB-SECTION IC - Specific Technical Requirements (C & I)

SUB-SECTION ID – Datasheet-A

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS SPECIFIC TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: I
		SUB-SECTION: IA
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION – IA**SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)**

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section – 2
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GENERAL PROJECT INFORMATION		

CONSULTANT : PROCON ENGINEERS

	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section – 2
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<u>CLAUSE NO.</u>	<u>DESCRIPTION</u>
1.0	INTRODUCTION
2.0	APPROACH TO SITE
3.0	LAND
4.0	SOURCE OF COAL
5.0	SOURCE OF WATER
6.0	ASH DISPOSAL AREA
7.0	PROJECT INFORMATION

CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
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CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section – 2
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1.0 <u>INTRODUCTION</u> The proposed 1x 660 MW Bhusawal Thermal Power Project will be set up by Maharashtra State Power Generation Co. Ltd. (MAHAGENCO) in Dipnagar near Bhusawal, Maharashtra, India. The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given herein under is for general guidance and shall not be contractually binding on the Owner. All relevant site data/information as may be necessary shall have to be obtained /collected by the Bidder. 2.0 <u>APPROACH TO SITE</u> Deepnagar is well connected by rail and road. By road, it is about 8 Km from Bhusawal city. Nearest railway station is at Bhusawal. The nearest Airport is at Aurangabad. The nearest sea port is at Mumbai. The site is located on the Mumbai-Nagpur Highway. 3.0 <u>LAND</u> Bhusawal Thermal Power Plant is already having 1x62.5 MW + 2x210 MW Units and Two (2) Units of 500 MW each are under execution stage. About 108.94 Hectares of land is acquired by MAHAGENCO near existing TPS. It is proposed to install 1x 660 MW unit on this land. 4.0 <u>SOURCE OF COAL</u> Indian coal would be sourced from Machaakata coal blocks in Orissa state. The Coal will be received at Plant site directly by rail. The coal from the railway wagons would be unloaded by means of wagon tipplers and will be either bunkered or stacked in the stock pile at site. 5.0 <u>SOURCE OF WATER</u> The main source of water is considered Ozerkheda Reservoir which is located at around 18 km from plant site.		

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
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6.0 <u>ASH DISPOSAL AREA</u> The ash generated from 1 x 660 MW unit shall be disposed off in slurry form to the existing Ash Pond located at Velhala, approx. 12 Km from the site.		
7.0 <u>PROJECT INFORMATION</u>		
7.1	Client / Owner	: Maharashtra State Power Generation Co. Ltd.
7.2	Consultant	: Procon Engineers, Navi Mumbai (Division of Nimoto Consulting Engineers Pvt. Ltd.)
7.3	Project Title	: BHUSAWAL T.P.S. UNIT – 6 : 1X660 MW
7.4	Location	: Dipnagar, Near Bhusawal, Maharashtra, India
7.5	Nearest railway station	: Bhusawal
7.6	Nearest Airport	: Aurangabad
7.7	Nearest Harbour	: Mumbai
7.8	Access Roads	: NH 6 (Mumbai-Nagpur Highway)
7.9	Elevation above MSL	: 210 M
7.10	Longitude/latitude	: 75° 51' 10" East / 21° 02' 30" North
7.11	Seismic Zone	: Zone III as per IS:1893
7.12	<u>AMBIENT TEMPERATURE</u>	
7.12.1	Mean of daily maximum temperature	: 48.25 °C (during May)
7.12.2	Mean of daily minimum temperature	: 18 °C (during January)
7.12.3	Highest temperature recorded	: 48.7°C

CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.		Volume: II
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7.12.4	Lowest temperature recorded	: 13°C	
7.13	Wet bulb temperature	: 27°C (Maximum)	
7.14	Rainfall	: 112 mm average annually	
7.15	Wind Speed	: 0 to 39 Km/hr	
7.16	Wind direction	: East North East to West South West	
	<u>ELECTRICAL</u>		
7.17	<u>MAIN POWER SOURCE FROM GRID</u>		
7.17.1	Rated Voltage	: 400kV	
7.17.2	Voltage variation	: $\pm 10\%$	
7.17.3	Frequency Variation	: $\pm 5\%$	
7.17.4	Rated Short Circuit Level	: 50 kA, Three Phase Symmetrical	
7.18	<u>AUXILIARY POWER SUPPLY</u>		
	Auxiliary electrical equipment shall be suitable for operation on the following supply system:		
7.18.1	Motors above 1000 kW & other Power devices	: 11kV, 3Ph, 3wire, 50Hz system	
7.18.2	Motors below 1000 kW & above 160kW & other power devices	: 3.3kV, 3 ph, 3 wire 50 Hz, Non Effectively earthed	
7.18.3	Motors upto 160 kW & other power devices	: 415V, 3 ph, 4 wire 50 Hz	
7.18.4	Motor Starting Methods	: Direct on Line	
7.18.5	(a) Lighting fixtures, Space heaters, and single Phase motors	: 240V, 1 phase, 50 Hz Supply through suitably rated transformers to limit the short circuit level to 9kA – 1 sec.	

CONSULTANT : PROCON ENGINEERS

 MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II	
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(b) Control & : 240V, 1 Phase, 50 Hz from UPS Instrumentation 7.18.6 Short circuit levels of 11kV, 3.3 kV and 415V system equipments The equipment shall be suitable for the following short circuit levels (a) 11kV Switchgears : 44 kA/3 sec (b) 3.3kV Switchgears : 40 kA/3sec (c) 415V PCC/ : 50 kA/1sec PMCC/ MCC (d) Lighting : 9 kA/1sec Distribution Boards & 240V A.C. supply 7.18.7 Auxiliary DC supply The auxiliary DC supply will be used for control, indication & protection, Turbine lube oil system, AVR, Emergency DC lighting of power plant and Control & Instrumentation etc. (a) Voltage : (i) 220V DC for utility purpose (ii) 24V DC for Control and Instrumentation (b) Voltage variation : + 10 %, - 15 % 7.18.8 Emergency power supply (a) Purpose : (i) Standby power to normal incomer of emergency MCC (ii) Alternate power source to Fire water Pumps (b) Rated voltage and frequency : 415 V, 3 phase, 3 wire, 50 Hz.		

CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: II
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7.18.9 UPS power supply (a) Purpose : (i) Vital process loads (ii) Critical lighting (iii) Control and Instrumentation (iv) Office for LAN power supply/Server etc. (b) Rated Voltage : 415V, 3 ph, neutral/240V single phase, 50Hz 7.19 The variation in voltage and frequency may be $\pm 10\%$ and $\pm 5\%$ respectively. The combined voltage and frequency variation may be $\pm 10\%$. All devices shall be suitable for continuous operation over the entire range of voltage variation without any change in their performance 7.20 Power socket shall be 415V AC, 50 Hz, 4 pin 32/63 Amps. Power socket outlets for portable tools, hand lamps etc shall be 240 volts, single phase, 3 pin, metal clad industrial type 7.21 All electrical equipment shall be designed for the following ambient conditions (a) Maximum ambient temperature : 50°C (b) Minimum Ambient temperature : 13°C		

CONSULTANT : PROCON ENGINEERS

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL	SPEC. NO.: PE-TS-415-165-N02A
		SECTION: I
		SUB SECTION: IA
		REV. NO. 00 DATE 02.05.19
		SHEET 1 OF 6
1.00.00	DELETED.	
2.00.00	SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:	
2.01.01	Scope (Mechanical):	
	a) Incoming hot water piping, including vertical run, supported on cooling tower, Motorized Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as per enclosed NDCT GA Drg. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a Pressure Gauge & Temperature Gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope. b) Inlet louvers, tower fills & fill supports, drifts eliminators, including all supporting structures, fastening arrangements & accessories. c) Screens, along with guides embedded in concrete shall be provided at the outlet of cold water channel. d) Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin. e) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates. f) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels. g) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall. h) Water Distribution system consisting of troughs/ Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply. i) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 100 M from sludge pit. j) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.	
2.01.02	Scope (Electrical):	
	a) Complete electrical equipment as per specification/ details indicated in Section IIA shall be in bidders' scope. b) The scope of power & control cables & special cables shall be as per section IIA (electrical). c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.	
2.01.03	Scope (C & I):	
	a) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test. b) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P.	

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL	SPEC. NO.: PE-TS-415-165-N02A
		SECTION: I
		SUB SECTION: IA
		REV. NO. 00 DATE 02.05.19
		SHEET 2 OF 6
	c) One no. of Anemometer for measurement of wind velocity. d) One no. of Psychrometer. e) Local Control Panel for Sump/Sludge Pumps (Submersible type). f) Level switches for sump/tank level high/normal/low/very low interlocks. g) Actuator for Motorised BFV at inlet of hot water pipes.	
2.01.04	Scope (Civil):	
	a) Complete civil works as detailed in Book 2 of 2 (Civil Specification) including excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc. The scope of this work shall consist of , but not limited to, the construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including Piling, if required), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution troughs, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs, sludge pit for each basin section, all other staircases/ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts, including fabrication, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure etc. b) Supply & application of painting at site including lettering on the outer wall of the cooling tower as per customer requirement.	
2.01.05	The following are also included in bidder's scope: a) One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers. b) Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary. c) Supply of first fill of lubricants for all equipments under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant. d) Supply of commissioning spares on as required basis. e) Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.	
3.00.00	Equipment & Services to be provided by Purchaser:	
	a. Supply and erection of incoming hot water piping up to bidder's terminal point.	

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL	SPEC. NO.: PE-TS-415-165-N02A
		SECTION: I
		SUB SECTION: IA
		REV. NO. 00 DATE 02.05.19
		SHEET 3 OF 6
	b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, if applicable. c. Cold-water outlet channels for cooling tower beyond the bidder's terminal point. d. For Electrical, C&I and Civil works, refer Sections IB/IIB, IC/IIC and Book 2 of 2 respectively enclosed herein.	
4.00.00	The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'II'. In the event of any conflict between Section -'II' & section 'I', the section 'I' shall prevail. In case of any contradiction in different clauses/parts of Section-I or any other clause of specification, the most stringent requirement shall prevail.	
5.00.00	DELETED	
6.00.00	DELETED	
7.00.00	DELETED	
8.00.00	PERFORMANCE TESTING AT SITE	
8.01.00	Scope:	
	To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test at site in presence of employer / purchaser at site.	
8.02.00	Codes:	
	The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder. a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version). b) BS-4485: Specification for Water Cooling Tower. c) BS-1042: Methods for the measurement of fluid flow in pipes. d) BS-3435: Measurement of electrical power and energy in acceptance testing. e) ASME 19.5: Supplements on instruments and apparatus.	
8.03.00	Conductance of tests:	
	Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified	
8.03.01	The bidder shall submit cooling tower performance test procedure as per ATC 105 for approval & conduct the test as per the approved procedure, in the event of order.	
8.03.02	The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.	
8.03.03	Cooling Tower performance shall be tested jointly by Contractor in presence of BHEL and Owner. All the representatives shall jointly record data of test. a) The responsibility for conducting the test will be with the bidder. b) All test instruments required for the PG test will be provided by contractor and meets the stipulations of the CTI ATC 105. c) Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments should be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments should be valid for the period of test. d) List of instruments to be arranged by the bidder along with the calibration certificates of the instruments to be used and psychometric charts and tables should be submitted to owner for	

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660 MW BHUSAWAL	SPEC. NO.: PE-TS-415-165-N02A
		SECTION: I
		SUB SECTION: IA
		REV. NO. 00 DATE 02.05.19
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	approval.	
8.03.04	PG test shall be carried out by the bidder after completion of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.	
8.03.05	Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished to the successful bidder. Performance curves applicable to 80%, 90%, 100%, 110% and 120% of the design water flow rate shall be furnished to the successful bidder.	
8.03.06	The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify/rectify/replace the fills and other materials associated with the performance of tower as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only twice during the contract period. All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).	
8.03.07	In case the test cold water temperature as determined from the PG test is higher than the predicated value (based on the performance curves). Purchaser reserves the right to accept all the towers after assessing the Penalty for performance of the cooling tower as per the revised clause 11.00.00 mentioned.	
9.00.00	The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.	
10.00.00	It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the ' Schedule of Deviations ' only. In the absence of the deviations listed in the ' Schedule of Deviations ', the offer shall be deemed to be in full conformity with the specification notwithstanding anything else stated elsewhere in the offer, data sheets etc. The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser.	
11.00.00	PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES	
	Bidder is responsible for workmanship & material supplied for the cooling tower. a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified. In case the test cold-water temperature as determined from the PG test is higher than the predicted value. Owner reserves the right to reject/replace the fills and other materials associated with the performance of the tower. In the event of acceptance by purchaser, penalty of 5% of contract value shall be deducted. b) The successful bidder shall demonstrate the above guarantees during performance testing at site. The purchaser is, however, not bound to accept the equipment and reserves the right to out rightly reject it if the actual values exceed beyond the plant design limits.	

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		SECTION: I
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		SHEET 5 OF 6
12.00.00	INSPECTION AND TESTING:	
	Purchaser/ Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.	
12.01.00	The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.	
12.02.00	Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.	
12.03.00	Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.	
12.04.00	Visual, dimensional checking of all components of each cooling tower.	
12.05.00	Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.	
12.06.00	Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.	
12.07.00	Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.	
13.00.00	QUALITY PLAN:	
13.01.00	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc. Following standard QP are enclosed for bidder's guidance: • Cooling tower • Pipes, fittings & pipe work • BF Valves • Chain Pulley Blocks • Gate/ Globe Valves • Submersible Pumps	
13.02.00	The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.	
13.03.00	For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.	
14.00.00	Tests at Site:	
14.01.00	After completion of erection and commissioning of the cooling tower, supplier in accordance with cooling tower Institute Bulletin No ATC-105 "Acceptance Test Procedure for Industrial Cooling Tower" shall carry out performance tests of each cooling tower.	

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14.02.00	Necessary correction curves shall be furnished by the Purchaser to include in Test procedure for correcting the test results for any difference between test and guarantee design conditions.
14.03.00	All mounting and calibrating instruments required for site performance tests shall be arranged by the cooling tower supplier without any extra cost.
15.00.00	DRAWINGS, CURVES AND INFORMATION REQUIRED: DELETED
16.00.00	Successful bidder in the event of award of contract shall furnish the drawings/ documents for all temporary structures, all erection methodologies, bought items or self-manufactured and/or fabricated items.

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			VOLUME: II B
			SECTION: D1
			REV. NO. 0 DATE 16.01.18
			SHEET 1 of 6
1.0	GENERAL INFORMATION		
	No. of Cooling Towers required	:	One (01) No.
	Location		Out door
	Duty		Continuous
	Type		Natural draught Counter flow with PVC Film fill type (Double edge folded/edge thickened -cross fluted
	Finished ground level		EL 1.5 M
	Basin Kerb level (Basin Sill Top level)		EL 1.8 M
2.0	DESIGN PERFORMANCE FOR EACH COOLING TOWER		
2.1	Design Cooling water flow	:	74000 M ³ /hr.
2.2	Design ambient wet bulb temp.	:	27.0 °C
2.3	Design inlet air wet bulb temperature.	:	27.0 °C
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0°C)	:	5.0 °C
2.5	Cold water temperature	:	32 °C
2.6	Hot water inlet temperature	:	42 °C
2.7	Cooling Range	:	10 °C
2.8	Design ambient Relative Humidity	:	40 %
2.9	Liquid Handled	:	Clarified Water (refer details of cooling water analysis at Annexure-3)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below: - Static head w.r.t. FGL - Frictional losses within bidders T.P. with 10% margin - Velocity head	:	Not to exceed 13.8 MWC
2.10	Maximum permissible drift loss	:	Max. 0.01 %
2.11	Design pressure for hot water distribution system	:	5.5 kg/cm ² (g)
2.12	Maximum foundation Diameter (outermost edge of foundation)	:	NA
2.13	Minimum Basin Diameter	:	128.22 M

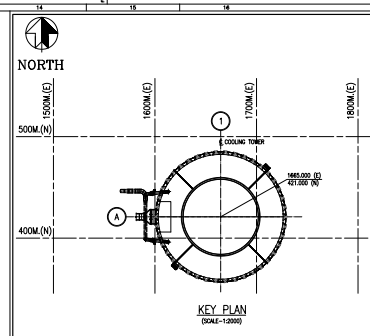
	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
			VOLUME: II B
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2.14	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	Min 120% of design CW flow.
3.0	SPECIAL FEATURES		
3.1	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement.
3.2	Whether fills are removable	:	Yes
3.3	Fills supporting by nailing acceptable	:	NO
4.0	Cold Water Basin Details		
4.1	Finished ground level	:	EL 1.5 M
4.2	Maximum water level	:	EL 1.5 M
4.3	Min. Water level	:	EL (-) 0.15 M
4.4	Storage capacity between Normal and minimum water levels.	:	16 minutes (Between Max. & Min. Water Level) of Cooling tower design Flow.
4.5	Invert level of CT Basin	:	EL (-) 0.65 M
4.6	Invert level of CW Channel near CT level	:	EL (-) 3.8 M
4.7	a) Depth of Sludge pit	:	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/channel invert level
	b) Submersible type sludge pumps	:	1 working + 1 standby (Min capacity of 200 cub M / hr)
4.8	Number of sludge pits	:	Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.
4.9	Number of cold water outlet channels	:	One for each compartment of CW basin. Cold water outlet shall be designed for flow velocity through them within 1.2 M/sec during the rated flow from cooling tower, with the minimum water level in the cold water basin. At T.P Bidder to match same as per GA Drawing.
4.10	Depth of CW channel		5.3 M from FGL (Ref Annexure-1)
4.11	Number of screens and gates in common outlet channel	:	As per GA drg.
4.12	Maximum allowable effective velocity through Cold water channel at Min. Water Level	:	1.2 M/Sec.
4.13	Maximum allowable effective velocity		1.2 M/Sec.

	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
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			REV. NO. 0 DATE 16.01.18
			SHEET 3 of 6
	through gates at Min. Water Level	:	
4.14	Max. allowable effective velocity through screens at Min. Water Level	:	1.2 M/Sec.
4.15	Length of outlet channel including expansion joint in bidder's scope	:	As per GA drg Annexure-1.
5.0	COOLING TOWER ACCESS DETAILS		
5.1	Required number of stair cases from ground level up to hot water inlet for convenient access to top & interiors of Cooling tower	:	Two (2) Nos.
5.2	Number of cage ladders from ground floor to cooling tower top.	:	Minimum Four (4) Nos.: Two from reinforced concrete stairs to platform at the top of the tower and other two shall be from ground level itself.
5.3	Internal walkway of platform with hand rails	:	Walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. Clear width of walkways shall be 1.5M.
5.4	External walkway platform	:	1.2 M width around the circumference at top and at each aviation lamp levels
5.5	Platform for access of BFV	:	To be Provided by Bidder
6.0	HOT WATER SUPPLY HEADER TERMINALS	:	As per terminal point Annex-2 enclosed. CW piping in BHEL scope 3240mm X 20mm thk. shall be terminated with centre line of pipe elevation as shown in sketch. Further Piping from T.P. with isolating Motorized B.F. Valves in each riser shall be in bidder's scope.
7.0	SCOPE OF SUPPLY :		
7.1	Cooling tower basin outlet channels/ sump and sludge pits	:	Yes
7.2	Hot water piping to distribution Duct	:	Yes
7.3	Hot water header isolation valves(motorised) on risers	:	Yes
7.4	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
7.5	Screen & guide for each cold water outlet sump/ channel	:	Yes
7.6	Stop Log gate with guides and sealing device for each cold water outlet sump/ channel.	:	Yes
7.7	Isolation valves in sludge pit	:	Yes

	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
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			REV. NO. 0 DATE 16.01.18
			SHEET 4 of 6
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Pulley block for lifting each screen and stop log gate in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied	:	Yes
7.12	Drift Eliminator	:	Yes
7.13	Electrical		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes
8.0	MATERIAL OF CONSTRUCTION		
8.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
8.2	Shell/Casing & Superstructure	:	R.C.C
8.3	Basin partition wall	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/Ladders	:	R.C.C./ HDG Steel
	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin	:	R.C.C
8.7	Hot water distribution nozzles	:	High Density Polyethylene or polypropylene or approved equal
8.8	Fills	:	PVC Film Fill
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC UV Stabilised
8.12	Fasteners/wetted parts	:	SS-316
8.13	Piping	:	Above 150 Nb : Carbon steel plates to IS 2062 internally lined with anticorrosive coal tar epoxy paint of min. 200 Microns DFT, rolled and welded as per IS 3589 Below and 150 Nb : IS 1239 (Heavy Grade)

	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
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			REV. NO. 0 DATE 16.01.18
			SHEET 5 of 6
8.14	Hot Water Distribution Pipes (Inside CT)	:	AC / PVC
8.15	Hot water line valves	:	
	a) BF Valves	:	Body: CI as per IS-210, FG-260 Shaft: SS304 as per ASTM A-479 Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves	:	
	Body	:	CI as per IS-210, FG-260
	Spindle & Trim	:	SS
8.16	Sludge outlet pipe	:	CI IS-1536, LA
8.17	Submersible Pumps	:	Casing: CI as per IS-210, FG-260 Impeller: Stainless Steel
8.18	Sluice gates with rubber seals in cold water outlet channel	:	As per appropriate class of IS: 3042, all mild steel parts to be galvanised.
8.19	Guide for stop log gates	:	SS- 304L
8.20	Screen	:	SS 304L
8.21	Guide for Screen	:	SS- 304L
8.22	Bolts, butts & other hardware	:	SS-316 (for wetted) and MS for other
Note:			
(a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.			
(b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.			
9.0	Pipe work Painting / Protection of Pipes:		
9.1	Internal surface	:	Surface preparation : Sand blast to SA 2.5 Internal Paint: Application of adequate nos of coats Epoxy resin based red oxide primer paint or approved equal so as to achieve the required minimum 140 DFT. Inner surface painting shall be applied at the fabrication yard before laying the pipes in position, leaving about 200 mm at both ends for welding of joints. This portion shall be painted after completion of laying and jointing.
9.2	External surface – over ground piping	:	Surface preparation : Sand blast to SA 2.5 External Paint: One coat of coal tar primer before dispatch from fabrication yard. After installation, the part of the pipe line from where priming coat has been rubbed off shall be retouched with primer. Then two coats of synthetic enamel paint of approved quality and colour shall be applied. The paint must be compatible with applied coal tar primer.

	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
			VOLUME: II B
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9.3	External surface – Burried piping	:	Surface preparation: Sand blast to SA 2.5 External Paint: One coat of coal tar primer of approved quality followed by coal tar based synthetic primer and single layer of 4 mm coal tar tape conforming to AWWA-C-203: 2002/IS-15337:2003. The pipes that will be buried underground shall be spark tested after completion of wrapping of each sections/ field jointing to check the quality of insulation that has been provided in the pipe.
	INSPECTION AND TESTING		
10.0	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.1	Material testing and identification	:	Required
10.2	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.3	Hydrostatic test for piping & valves required	:	Yes
10.4	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.5	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.6	Field performance test to be done by	:	By Bidder
10.7	All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
10.8	All testing instruments by supplier	:	Yes
10.9	Commissioning at site by	:	Bidder
10.10	Mandatory spares	:	NA
Attachments: a) GA of NDCT. Annexure-1. b) Thermal design calculations- Annexure-2. c) Cooling water Analysis – Annexure-3			



- [illegible]

LEGEND:

- LEGEND:-**
- | | | |
|-----------|---|---------------------------|
| FGL | = | FRESH GROUND LEVEL |
| BOP | = | BOTTOM OF PIPE |
| THP | = | TYPICAL |
| TP | = | TERMINAL POINT |
| EJ | = | EXPANSION JOINT |
| AOI | = | AVATION OBSTRUCTION LIGHT |
| CW OUTLET | = | COLD WATER OUTLET |
| PVC | = | POLYVINYL CHLORIDE |
| PP | = | POLYPROPYLENE |

DESIGN DUTY PARAMETERS:-

WATER FLOW	: 74000 M ³ /HR
HOT WATER TEMPERATURE	: 42°C
COLD WATER TEMPERATURE	: 37°C
WET BULB TEMP.	: 27°C
RELATIVE HUMIDITY	: 40%
PUMPING HEAD	: 13.8 MWC w.r.t FGL

SPACE FOR APPROVAL STAMP

 MAHARASHTRA STATE POWER GENERATION CO.LTD.
BHUSAVAL TPS UNIT-6 : 1 X 660 MW PROJECT

OWNER CONSULTANT

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
WASHE NAWI MUMBAI

1 X 660 MW BHUSAWAL T.P.S. UNIT-6 TPP

BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT

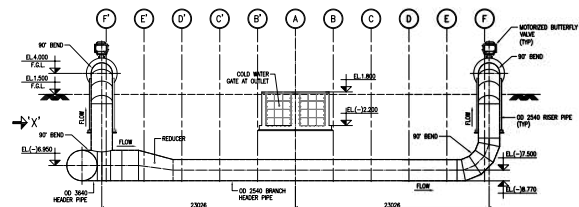
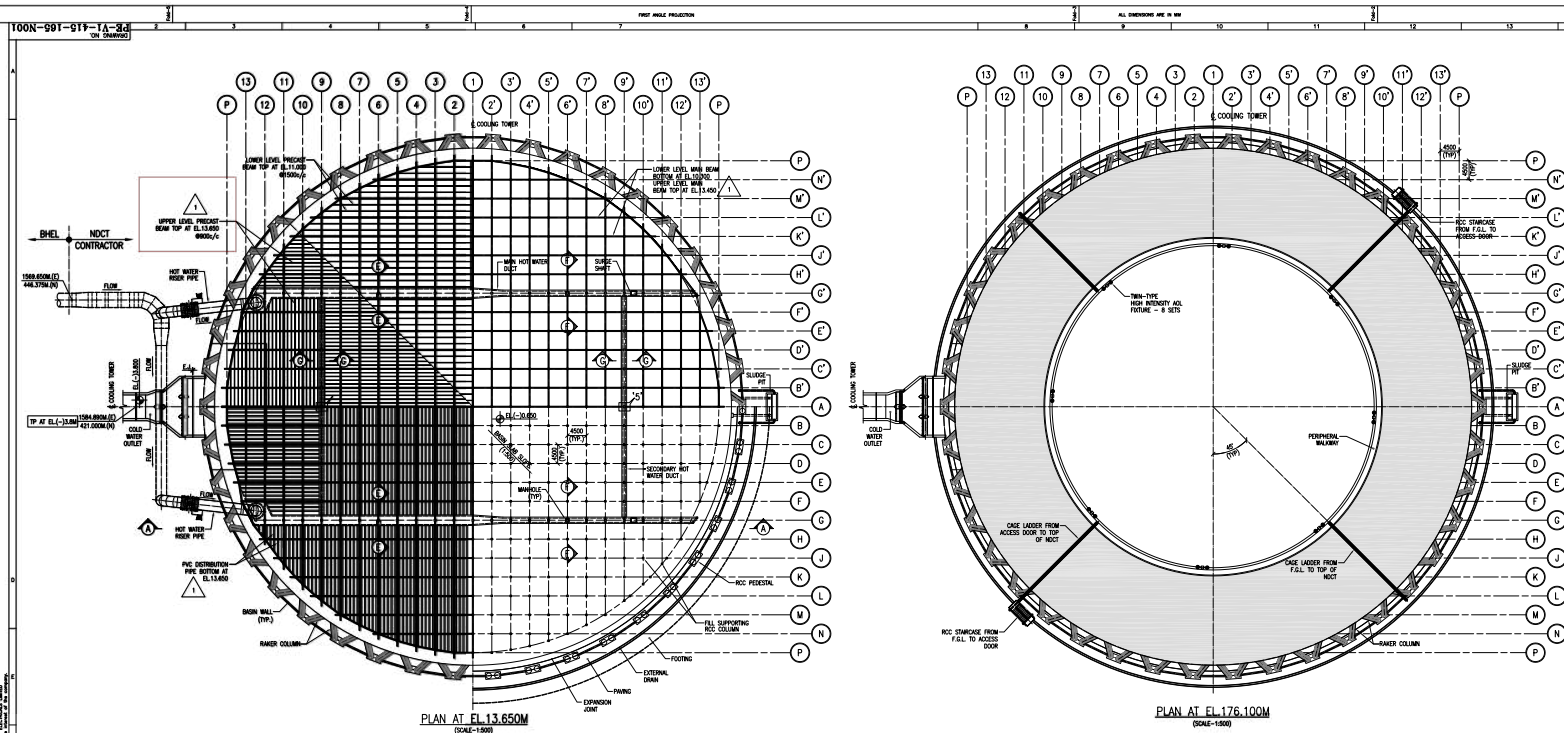
NDCT CONSULTANT	SPECTRUM Techno Consultants Pvt. Ltd. Vashi, Navi Mumbai

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		C	DES	UNB	07.02.2015
			CHD	UNB	07.02.2015
			AGN	UNB	07.02.2015

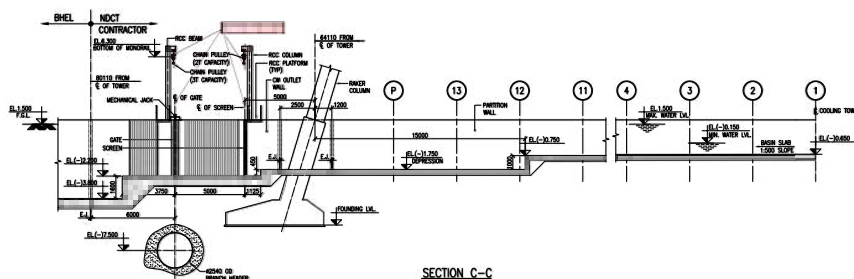
TITLE	GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER

CUSTOMER PACKAGE CODE			CWL			SCALE AS SHOWN 	DRAWING NO. PE-V1-415-165-N001	
DISCIPLINE	M	C	E	I	L		SHEET 1 OF 3	REV. 1

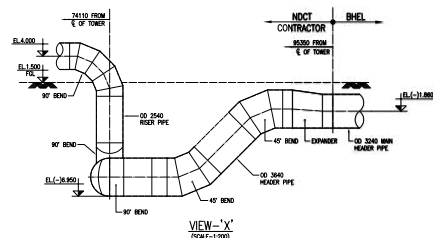
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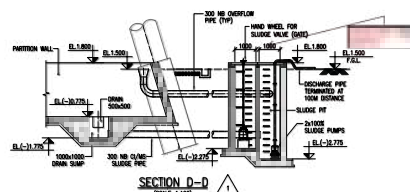
SECTION B-B



SECTION C-C



VIEW-'X'



SECTION 1

					JOB NO. 415				
					STATUS CONTRACT				
					DISTRIBUTION				
					TO				
					NO. OF				
REV	DATE	ALD	CHD	APPD	REV	DATE	ALD	CHD	APPD
					1	07.02.19	ODS	UNB	UNK
					REVISED AS PER MANAGEMENT/DOPL COMMENTS W/ LETTER NO. 18100-1819-LOT-046E-0132 DATED 04-02-2019 CHANGES MARKED AS- 				

MAHARASHTRA STATE POWER GENERATION CO.LTD. BHUSAWAL T.P.S. UNIT-6 : 1 X 600 MW PROJECT			
OWNER CONSULTANT 	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS		
1 X 600 MW BHUSAWAL T.P.S. UNIT-6 TPP			
BHARAT HEAVY ELECTRICALS LTD PROJECT ENGINEERING MANAGEMENT NOIDA			
NCDT CONSULTANT 	SPECTRUM Techno Consultants Pvt. Ltd. Vaikh, Noida Municipal		
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TITLE GENERAL ARRANGEMENT OF NATURAL DRAWING COOLING TOWER			
CUSTOMER PACKAGE CODE DISCIPLINE	DWG. M E E I	SCALE AS SHOWN 	PE-0145-416-105-N001 SHEET 2 OF 3 REV. 1

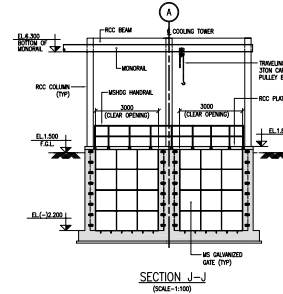
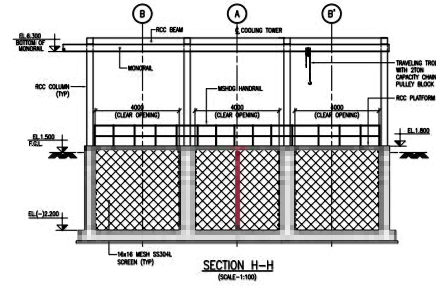
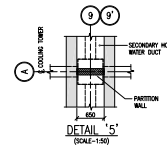
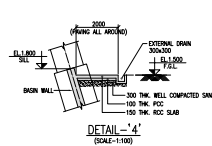
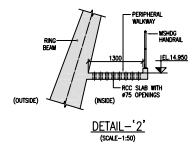
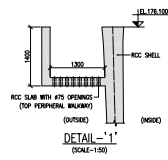
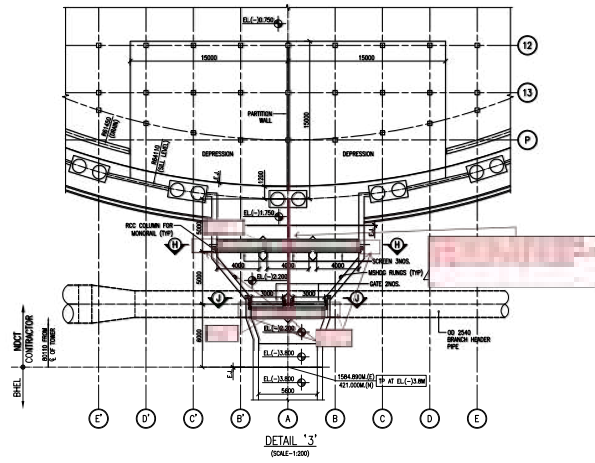
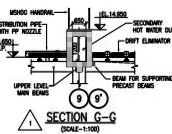
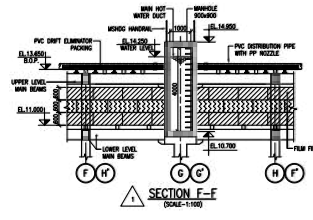
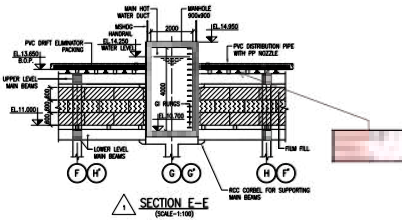
100N-001-019-1A-06

(SHEET 01 OF 03)

FIRST FLOOR PROJECTION

ALL DIMENSIONS ARE IN MM

- NOTES:-
1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
 2. DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
 3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1 & 2 OF THIS DRAWING.



SPACE FOR APPROVAL STAMP

MAHARASHTRA STATE POWER GENERATION CO.LTD.
BHUSAWAL T.P.S. UNIT-6 : 1 X 660 MW PROJECT

OWNER CONSULTANT
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
VASHI, NASHIK, MUMBAI

1 X 660 MW BHUSAWAL T.P.S. UNIT-6 TPP

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

NOT CONSULTANT
SPECTRUM Techno Consultants Pvt. Ltd.
Vashi, Navi Mumbai

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TITLE
GENERAL ARRANGEMENT OF NATURAL
DRAUGHT COOLING TOWER

CUSTOMER PACKAGE CODE
DISCIPLINE
SCALE AS SHOWN
DRAWING NO.
SHEET 3 OF 3
REV. 1

Mar 08, 2019 - 2:30pm

REV	DATE	ALTO	CHD	APPO	REV	DATE	ALTO	CHD	APPO
1	27.02.19	CHD	CHD	CHD	1	27.02.19	CHD	CHD	CHD

REVISAS PER MANAGEMENT/DEPT.
CONTRACTOR AND LATER NO.
100N-001-019-1A-06-01
DATED: 04-02-2019
MARKED AS:-

TITLE BLOCK

ANEXURE-2

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD. (MAHAGENCO)					
	DEVELOPMENT CONSULTANTS PVT. LT MUMBAI					
	BHARAT HEAVY ELECTRICALS LIMITEI					
	SPECTRUM TECHNO CONSULTANTS PVT L NAVI MUMBAI					
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company.		DEPT. CODE C	DESN CHD APPD	NAME UNB UNB UK R	SIGN   	DATE 27-FEB-19 27-FEB-19 27-FEB-19
TITLE : THERMAL AND HYDRAULIC CALCULATIONS FOR NATURAL DRAUGHT COOLING TOWER						
		DEPT.			DOCUMENT NO. PE-V1-415-165-N003	
		SIGN				
					SHEET 1 OF 10 REV. 1	



	PROJECT TITLE: 1x660 MW BHUSAVAL THERMAL POWER PROJECT			Doc. No.	PE-DC-415-172-N001
	PACKAGE: NATURAL DRAUGHT COOLING TOWER			Rev. No.	1
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS			Date	27.02.2019
	DOCUMENT TYPE: DESIGN DOCUMENT			Page No.	2
1	General				
1.1	Design Duty Parameters				
	Circulating Water Flow	74000	m ³ /hr		
	HWT	42	°C		
	CWT	32	°C		
	Design WBT	27	°C		
	Relative Humidity	40	%		
	Range	10	°C		
	Approach	5	°C		
	Basin Kerb above Max. WL	500	mm		
	Site Elevation above MSL for thermal design	0	m		
	Ambient Pressure	101325	N/m ²		
	Salinity	0	ppm		
1.2	Tower Sizing Data				
	Type of Fill	PVC FILM FILL (C.10.19)			
	Fill Height	1.8	m		
	Top of Air Inlet above basin kerb	8.5	m		
	Bottom of Fill above Sill level	9.25	m		
	Top of Fill above Sill	11.05	m		
	Bottom of distribution Pipe (BOP) above Fill	0.7	m		
	Static Head up to BOP w.r.t Sill	11.75	mWC		
	Center line Dia.of tower at basin Sill level	128.22	m		
	Internal Diameter of tower at basin sill level	127.22	m		
	Internal Diameter at top of Fill level	120.59	m		
	Gross Fill Area	11421.219	m ² =====>	A	
	Length of each HW Duct	108.9	m approx.		
	Outer Width of each HW Duct	2.5	m approx.		
	Area of HW Ducts	544.5416454	m ² =====>	B	
	Column Obstructions	141.25	m ² =====>	C	
	Net Fill Area Available	10735.428	m ² =====>	(A-B-C)	
	Effective Fill Area considered in design	10383.170	m ²		
	Water Loading Rate	7.127	m ³ /hr/m ²		
	Liquid to Gas Ratio	1.949			

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER PROJECT				Doc. No.	PE-DC-415-172-N001	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER				Rev. No.	1	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	27.02.2019	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	3	
1.2.1	Basin Sizing Calculations						
	Max. Water Level	EL (-) 0.15	m				
	Min. Water Level	EL 1.5	m				
	Difference between Max. & Min. Water Levels	1.65	m =====>>	d			
	Storage Capacity required between Max. & Min. Water Levels	16 minutes hold up					
	16 minutes' hold up water volume (= 74,000 m3/hr/60*16)	19733.33	m3 =====>>	V			
	Basin Area required for 16 minutes' hold up capacity	11959.60	m2 =====>>	(V/d)			
	Basin Diameter Required	123.40	m	(SQRT((V/d)*4/PI))			
	Basin Diameter Provided	127.22	m				
	Hence, Basin Diameter Provided	≥	Basin Diameter Required				
2	Thermal Calculations						
	Inlet air properties						
	Design WBT	27	°C				
	Relative Humidity	40	%				
	DBT	38.81	°C				
	Abs. Humidity	0.0178	kg/kg				
	Dry Air Density	1.0916	kg/m³				
	Air-Vapour mixture Density	1.1195	kg/m³				
	Enthalpy	20.309	kCal/kg				
2.1	KaV/L Calculations						
	KaV/L as per Tchebycheff Method						
		2.26	Calculations enclosed				
	KaV/L provided	2.26					
2.1.1	Exit Air Properties						
	WBT	40.43	°C				
	Relative Humidity	100	%				
	DBT	40.43	°C				
	Abs. Humidity	0.0504	kg/kg				
	Dry Air Density	1.0405	kg/m³				
	Air-Vapour mixture Density	1.0925	kg/m³				
	Enthalpy	40.847	kCal/kg				
	Enthalpy Gain	20.538	kCal/kg				
	Density Difference (Δ ρ)	0.027	kg/m³				
	Average of Air-Vapour mixture Densities	1.106	kg/m³				
	Dry Air Flow through the tower	10544.38	kg/s				

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER PROJECT			Doc. No.	PE-DC-415-172-N001	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER			Rev. No.	1	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS			Date	27.02.2019	
	DOCUMENT TYPE: DESIGN DOCUMENT			Page No.	4	
2.2	Draught Calculations					
	Draught Losses					
	Air Inlet + Rain Zone + Columns & Beams below Fill	1.6697	mmWC			
	Fill + Other Phenomenon	1.6834	mmWC			
	Distribution + D/E	0.3550	mmWC			
	Throat	0.3458	mmWC			
	Other Phenomena	0.3900				
	Total of draught losses	4.4440	mmWC			
	Draught Height Required ($\Delta p_d / \Delta \rho$)	164.592	m			
	Tower Height Required (Draught Height + 0.5*Fill Height + Air Inlet)	173.84	m			
	Tower Height Provided	174.30	m			
2.3	Check for Heat Balance					
	Dry Air Flow, G	37959768	kg/hr			
	Evaporation Loss	1237488.437	kg/hr			
	Specific Heat of Water	1	kCal/kg ^o C			
	Heat Lost by circulating Water	740000000	kCal/hr			
	Heat of Evaporated Water	39599629.98	kCal/hr			
	Total Heat Lost by Water	779599630	kCal/hr			
	Heat Gain by Air	20.538	kCal/kg			
	Total Heat Gain by Air	779617715	kCal/hr			
3	Draught Loss Calculations					
3.1	Loss through Inlet + Rain Zone + Other Phenomena below Fill					
	G	kg/s	10544.38			
	Abs. Humidity at Inlet	kg/kg	0.0178			
	Air-Vapour mixture Density at Inlet	kg/m ³	1.1195			
	Inside Base Diameter	m	127.22			
	Air Inlet Height	m	8.5			
	Shell Angle (average)	deg.	16.7			
	Air Inlet Area	m ²	3329.127			
	Air Flow Rate through inlet	m ³ /s	9586.4850			
	Air Velocity through inlet	m/s	2.8796			
	Effective rain area	m ²	10735.4277			
	Air Velocity through Rain Zone	m/s	0.8930			
	Draught Loss through Inlet + Rain Zone + Other Phenomena below Fill	mmWC	1.6697			

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER PROJECT			Doc. No.	PE-DC-415-172-N001	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER			Rev. No.	1	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS			Date	27.02.2019	
	DOCUMENT TYPE: DESIGN DOCUMENT			Page No.	5	
3.2	Loss through Fill					
	Gross Fill Height	m	1.8			
	Average Abs. Humidity	kg/kg	0.0341			
	Average Air-Vapour mixture Density through Fill	kg/m ³	1.106			
	G	kg/s	10544.38			
	Air Flow Rate through Fill	m ³ /s	9858.900			
	Effective Fill Area	m ²	10383.170			
	Average Air Velocity through Fill	m/s	0.950			
	Draught Loss through Fill	mmWC	1.6834			
3.3	Loss through Distribution System + Drift Eliminator Packing (DDE)					
	G	kg/s	10544.38			
	Abs. Humidity at Exit	kg/kg	0.0504			
	Air-Vapour mixture density at exit	kg/m ³	1.0925			
	Diameter at Distribution	m	120.170			
	Gross Area at Distribution	m ²	11341.797			
	Net Area at Distribution	m ²	7714.13			
	Effective Area considered in design	m ²	7714.13			
	Air flow rate through DDE	m ³ /s	10138.04737			
	Air Velocity through DDE	m/s	1.3142			
	Draught Loss through DDE	mmWC	0.3550			
3.4	Loss through Throat/Neck + Expansion					
	G	kg/s	10544.38			
	Abs. Humidity at Exit	kg/kg	0.0504			
	Air mixture/vapour density	kg/m ³	1.0925			
	Throat Diameter	m	75.1			
	Throat Area	m ²	4429.653			
	Air flow through throat	m ³ /s	10138.04737			
	Air velocity through Throat/Neck	m/s	2.289			
	Draught Loss across Throat + Expansion	mmWC	0.3458			

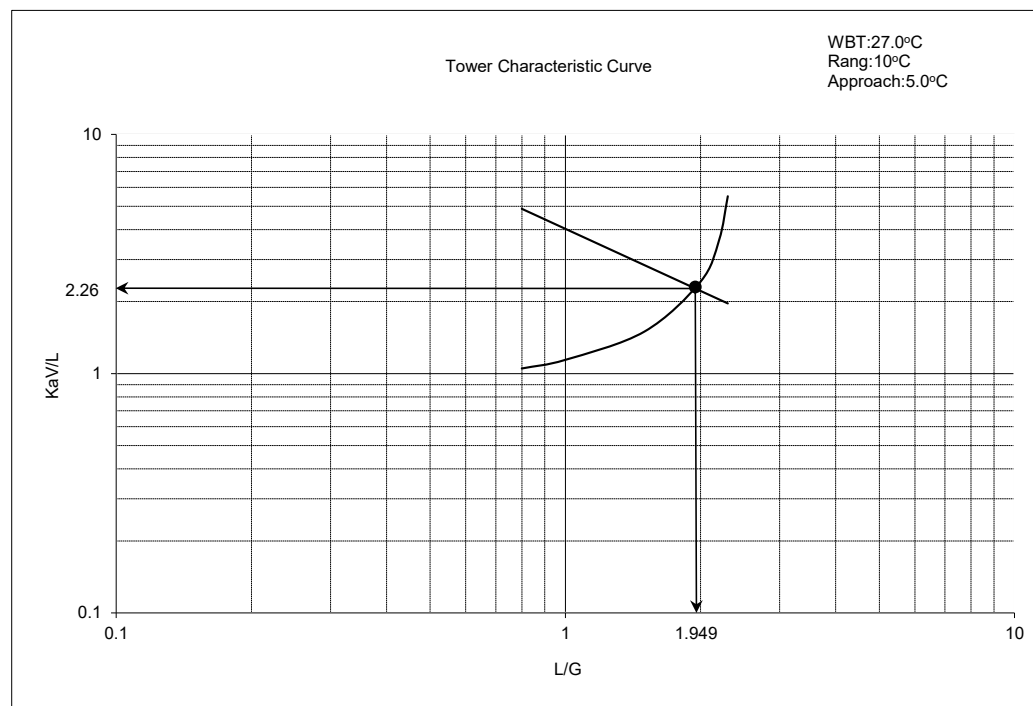
PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER PROJECT			PE-DC-415-172-N001			
PACKAGE: NATURAL DRAUGHT COOLING TOWER			1			
DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS			27.02.2019			
DOCUMENT TYPE: DESIGN DOCUMENT			6			
4	KaV/L Calculations (Chebyshev / Tchebycheff Method)					
	L/G	1.949				
	Range	10	°C			
	WBT	27	°C			
	h1	20.440	kCal/kg			
	h2 = h1+L/G*Range*Cp	39.930	kCal/kg			
T °C		T °K	hw, kCal/kg	ha, kCal/kg		hw-ha 1/(hw-ha)
32	T2	305.15		h1	20.440	
33	T2+0.1*Range	306.15	28.00733951	h1+0.1*L/G*Range*Cp	22.38884	5.6184949 0.1779836
36	T2+0.4*Range	309.15	32.64634636	h1+0.4*L/G*Range*Cp	28.23584	4.4105018 0.2267316
38	T1-0.4*Range	311.15	36.12371329	h2-0.4*L/G*Range*Cp	32.13384	3.9898687 0.2506348
41	T-0.1*Range	314.15	42.00798075	h2-0.1*L/G*Range*Cp	37.98084	4.0271362 0.2483154
42	T1	315.15		h2	39.930	
	KaV/L = Range/4*Σ1/(hw-ha)*Cp					Σ1/(Ew-Ea) 0.9036654
	KaV/L Required =	2.26				
	KaV/L Provided =	2.26				
5	Duty Coefficient (Dt)					
	Dt= A√H/(C√C)					
	where	A =	12711.61304	m ² (area at sill)		
			136756.6177	ft ²		
		H =	174.30	m (tower height)		
			571.704	ft		
		C =	3.2273120	Performance co-		
	Therefore, Dt=	563991				
6	Performance Coefficient (C)					
	C=	(1/(KaV/L) + L/(2G))*G/L*N ^{1/3}				
	We have	KaV/L =	2.26			
		L/G =	1.949			
		N =	Pd * 2g/(ρ*v ³)	No. of velocity heads		
	where	Pd =	4.4440	mmWC (tower pressure drop)		
		ρ =	1.106	air-vapour density in fill section		
		v =	0.950	afflux air velocity in fill section		
	Therefore, N=	87.44				
	Hence, C=	3.23				
7	Draught Factor (F)					
	F=	Δp/(1.64*10 ⁻⁸ *Δh)				
	We have	Δp =	0.027	kg/m ³ (difference in air-vapour mixture density at inlet and outlet)		
			0.0016875	lb/ft ³		
		Δh =	20.538	kcal/kg (difference in enthalpy at inlet and outlet)		
			36.9684	BTU/lb		
	Therefore, F=	2783				

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER STATION , UNIT-6				Doc. No.	PE-V1-415-165-N003	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER				Rev. No.	0	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	05.12.2018	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	7	
1	Pumping Head Calculations						
			Header Pipe	Riser Pipe			
	Inlet Pipe Diameter	m	3.6	2.5			
	Flow per inlet pipe	m ³ /hr	74000	37000			
		m ²	10.179	4.909			
	Velocity of Flow	m/s	2.019	2.094			
1.1	Friction Loss Through Pipes [as per Hazen-Willam Method]						
	D[m]	V[m/s]	C (for new pipe)	S	L[m]		P _d [m]
	3.6	2.019	120	0.000792506	5		0.0039625
	2.5	2.094	120	0.001296652	70		0.0907657
	Total Friction Loss Through Staright Pipes						0.0947282
1.2	Head Loss Through Fittings						
1.2.1	Welded Elbows [theeta=90, K=20f]						
	Flow [m3/s]	Dia. [m]	Vel [m/s]	Vh [mmWC]	f	K	Pd
	74000	3.6	2.019	0.2078594	0.0095	0.19034264	0.0395645
	37000	2.5	2.094	0.223439343	0.0101	0.20267371	0.0452853
	37000	2.5	2.094	0.223439343	0.0101	0.20267371	0.0452853
							0.1301351
1.2.2	TEE [K=60f]						
	37000	2.5	2.094	0.223439343	0.0101	0.60802113	0.1358558
1.3	Butterfly Vlaves [20f]						
	37000	2.5	2.094	0.223439343	0.0101	0.20267371	0.0452853
		Exit Dia.	Vel [m/s]	Vh [mmWC}			
1.4	Expansion Loss	3.5	1.068	0.055836571			0.0558366

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER STATION , UNIT-6				Doc. No.	PE-V1-415-165-N003	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER				Rev. No.	0	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	05.12.2018	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	8	
1.5	Discharge Loss						
	Discharge Velocity	m/s	1.068				
	Discharge Loss	mWC	0.0582				
1.6	Friction Loss through RCC Duct						
	Water Flow per duct (F)	m ³ /hr	37000				
	Duct Depth	m	3.3				
	Duct Width	m	2				
	Duct Wetted Area (WA)	m ²	6.6				
	Duct Perimeter (P)	m	10.6				
	Hydraulic Radius (R = WA/P)		0.623				
	Flow Velocity through Duct (V = F/WA)	m/s	1.557				
	Slope S = $(n * V / R^{2/3})^2$, n = 0.015	per m	0.001026224				
	Duct Length	m	108.8				
	Friction Loss through RCC Duct	mWC	0.111691				
1.7	Head Loss due to sudden turns and contraction						
	Turning into Sec. RCC Channel from Main. RCC Channel	mWC	0.0371				
	Sudden Contraction (Duct to Pipe)	mWC	0.0445				
1.8	Friction loss through PVC distribution piping (longest pipe considered)	mWC	0.0755				

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER STATION , UNIT-6				Doc. No.	PE-V1-415-165-N003	
	PACKAGE: NATURAL DRAUGHT COOLING TOWER				Rev. No.	0	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	05.12.2018	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	9	
1.9	Sum of Friction + Head Losses from S.No. 1.1 to 1.8	mWC	0.7888	=====> SFH			
2	Spray Nozzle Head	mWC	0.5	=====> SNH			
3	Sum of SFH + SNH	mWC	1.2888				
4	Static Head						
	Sill Level above FGL	0.5	m				
	Air Inlet Height above Sill	8.5	m				
	Fill Height above Air Inlet + Support Beam Depth	2.5	m				
	Top of Fill to bottom of distribution Pipe	0.7	m				
	Total Static Head above FGL	12.2	m				
5	Total Head Utilized						
	Friction/Head Losses + Static Head	13.489	mWC				
	Total Head Utilized is	≈	Total Head Available				

	PROJECT TITLE: 1x660 MW BHUSAWAL THERMAL POWER STATION , UNIT-6	Doc. No.	PE-V1-415-165-N003
	PACKAGE: NATURAL DRAUGHT COOLING TOWER	Rev. No.	0
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS	Date	05.12.2018
	DOCUMENT TYPE: DESIGN DOCUMENT	Page No.	10



 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: III-E1
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section-2
REV: R0	WATER TREATMENT SYSTEMS	Page 41 of 313

ANNEXURE-I

ANALYSIS OF RAW WATER

<u>SR. NO.</u>	<u>PARAMETERS</u>	<u>UNITS</u>	<u>VALUES</u>
1.0	pH		8.0 – 8.5
2.0	Temperature	°C	22 - 30
3.0	Conductivity	µS/cm	1300
4.0	Colour	Hazen Units	Not Available
5.0	Odour		Not Available
6.0	Taste		Not Available
7.0	TDS	ppm	870
8.0	P-Alkalinity as CaCO ₃	ppm	Nil
9.0	M-Alkalinity as CaCO ₃	ppm	400
10.0	T – Alkalinity as CaCO ₃	ppm	400
11.0	Organic Matter as KMnO ₄	ppm	50
12.0	Iron (as Fe)	ppm	1
13.0	Turbidity (NTU)	ppm	100 during Non – Monsoon Up to 10,000 during Monsoon
14.0	CATIONS		
	(a) Ca as CaCO ₃	ppm	295
	(b) Mg as CaCO ₃	ppm	77
	(c) Na as CaCO ₃	ppm	203

CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.		Volume: III-E1
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1		Section-2
REV: R0	WATER TREATMENT SYSTEMS		Page 42 of 313
<u>SR. NO.</u>	<u>PARAMETERS</u>	<u>UNITS</u>	<u>VALUES</u>
	(d) K as CaCO_3	ppm	10
	Total Cation	ppm	585
15.0	ANIONS		
	(a) HCO_3 as CaCO_3	ppm	400
	(b) Chlorides	ppm	149
	(c) SO_4 as CaCO_3	ppm	33
	(d) Fluoride as CaCO_3	ppm	1
	(e) Nitrate as NO_3	ppm	2
	Total Anion	ppm	585
16.0	Ammonia	ppm	Absent - Traces
17.0	Silica Colloidal (as SiO_2)	ppm	< 1 (can be present in summer)
18.0	Silica Non - Colloidal (as SiO_2)	ppm	36
19.0	Free Chlorine	ppm	Nil
20.0	Total Suspended Solids	ppm	Not Available
21.0	Carbonates as CaCO_3	ppm	Not Available
22.0	Boron	ppm	Not Available
23.0	Oil & Grease	ppm	Not Available

CONSULTANT : PROCON ENGINEERS

	1 x 660 MW Bhusawal Thermal Power Project	
	Technical Specifications for Natural Draught Cooling Towers	Doc No. : PE-V1-415-TS-101

SECTION-A: SCOPE OF WORK

1.0 This specification covers the general requirements of construction and erection features and performance testing and commissioning of Natural Draft hyperbolic cooling towers (NDCTs).

2.0 It is not the intent to completely specify all aspects and details of the structure / works involved. However, the work shall conform in all respects to high standards of engineering and international construction and erection practices. Contractor's workmanship shall be such that the NDCTs are able to perform in continuous commercial operation without problems to the Owner. The Owner shall have the power to reject any work or materials, which in his judgment are not acceptable or not in full accordance with codes and/or international practices.

2.1 Time is of essence in this contract and hence, the NDCT contractor is required to mobilize all plant and machinery, engineers, supervisors and labour in adequate numbers to ensure that the construction work of all the five NDCTs is taken up, progresses and finished simultaneously as per Customer's schedule.

Apart from the above mobilization requirement the NDCT Contractor may consider time saving methods like painting of the shell and laying of Electrical items like GI conductors, cables, etc. lift by lift while constructing the shell. All such innovative measures to speed up construct work is required to be undertaken by the NDCT contractor.

3.0 The Contractor shall furnish all that is necessary and as required and/or demanded by the Owner even if such information is explicitly not sought herein. The scope of work includes, but is not limited to the following.

- a) Construction of NDCTs including excavation, foundation, back filling, sand bedding, laying PCC, concreting, reinforcement, etc., providing electrically operated winches, jump formwork systems, separate lifts for movement of materials, passenger lifts to facilitate movement of staff and inspecting officers and proper communication system during construction period. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder.
- b) Reinforced concrete basin including basin drainage, stop log gates & screens including guide frames and gravity conduits / channel up to the terminal point.
- c) Material handling systems at CW channel, Sludge Pit, etc. wherever required.
- d) Disposal of surplus excavated earth as directed by the Engineer.
- e) Supply of all materials required at site for successful operation of NDCTs.
- f) Hot water distribution piping system within the terminal points including Risers, Motorized Butterfly Valves, Internal Distribution Pipes, nozzles, fittings and supports.
- g) Fill and its supporting frame works.
- h) External RCC Staircases, RCC Platforms and Steel/FRP Doors, internal RCC Walkways and external Cage Ladders.
- i) Hot dip galvanized MS handrails, fittings, fixtures, inserts etc., wherever required
- j) Complete Earthing & Lightning protection and Aviation Warning systems.

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- k) De-sludging arrangements with knife-edge gate valves and Sludge Pumps, complete with electric motors, NRVs, isolation valves, piping, etc.
- l) Water proof painting, Bitumastic or approved equivalent painting for all internal and external surfaces of basin, diagonal columns, fill supporting structure and inside surface of shell, and cement paint for external surface of shell as specified.
- m) Supply and erection of hoist and monorails as necessary.
- n) All necessary steel work, hardware etc.
- o) Aviation Obstruction Lighting System complete with twin AOLs fixtures, brackets, hardware, JB's, Cables, Photo Cells, Lighting and Control Panels, etc.
- p) Earthing & Lightning Protection System complete with GI coronal bands, GI down comers, fixtures, brackets, hardware, earth electrodes and risers and earth pits
- q) Pitot tubes, Psychrometers, Temperature and Pressure gauges, Anemometers, Level Switches, etc required for performance monitoring and operation of cooling towers.
- r) Trial commissioning and testing, including supply of all testing instruments and mounting the same. Also all isolating valves required on the flow measuring stubs shall be supplied by the Contractor during testing.

4.0 TERMINAL POINTS

- a. Hot water pipe (as shown in the GA drawing)
- b. Cold water channel (as shown in the GA drawing)
- c. Earthing & Lightning protection System

2 nos. of pig tails of tower circumferential earth mat for connection with plant earth grid. However earth mat interconnection between the cooling towers is in CT contractor's scope.

- d. Lighting, power receptacles & Aviation Obstruction Lighting System

ACDB input terminal and Aviation control panel's input terminal. Input terminals shall be suitable for Owner's 3 core cables.

- e. Instrument cables (at instrument junction box)
- f. Cables for drain pumps (input terminals of starter panel)

Note: Jointing at terminal points is in CT contractor's scope. If any of the terminal point is not ready, then the contractor shall leave the TP with all necessary jointing accessories such as PVC water stopper in channel etc., for connection by others.

5.0 SPECIFIC COMPLIANCE

It is necessary for the bidder to comply with the following documents/drawings enclosed with this specification:

- a. Thermal & Hydraulic Design Calculations
- b. General Arrangement of Natural Draught Cooling Tower
- c. Design Basis Report

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SECTION-B: MECHANICAL WORKS

1.0 GENERAL

The scope of Mechanical works and testing requirements are covered in this section. The specification gives a broad outline of the scope of work and services to be provided by the contractor and it is not the intent of this specification to cover all the granular details of the package. It shall be the responsibility of the contractor to provide all the necessary materials, works and services required to complete the project in all respects, even if the same are not explicitly mentioned in this specification.

All the detailed fabrication drawings shall be prepared by the contractor and got approved by the Engineer-in-Charge. All the latest revisions of relevant Indian and International standards are applicable in this contract.

1.1 MEASUREMENT & PAYMENT

For payment of work done under this section, the actual quantity erected in the NDCT as measured and approved by the Engineer-in-Charge shall be considered for payment. The quantities lost towards wastage, etc., shall be to the contractor's account and no bills toward wastages, etc. shall be entertained.

2.0 FILL

Fills are of PVC Film type. Fills should be supported on RCC beams in such a manner that movement in both horizontal & vertical directions are arrested.

The fills should not sag with all the working, scaling and temperature loads envisaged, including the induced vibrations.

The fill shape, size and configuration shown in the GA drawing enclosed with this specification must be followed without deviation. No changes in these aspects will be permitted.

3.0 HOT WATER DISTRIBUTION SYSTEM

Hot water should flow into the RCC Primary Ducts through MS Riser pipes that enter the NDCTs through the air inlet as shown in the enclosed GA drawing. It is preferred that the water discharges into the duct from the bottom.

A RCC Secondary Duct shall receive hot water from the Primary Duct for distribution into specific segments as per design.

The lateral distribution pipes embedded in the Primary and Secondary Ducts are fitted with down-spray type nozzles, which spray water uniformly over the fill. Spray pattern over the fill should be circular or square, but solid in either case to ensure equal and uniform distribution of water over the fill without resulting in dry spots at all plant loads.

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The complete water distribution system should be rigidly secured to the supporting structure as shown in the drawings.

3.1 PRIMARY DUCT

Primary duct is designed as a RCC channel with cast in-situ slab on top (i.e. closed on top). Each primary duct has 2 Nos. of 1000 mm (W) x 1000 mm (B) x 1000 mm (D) min. open surge shafts cum manholes with rungs to access duct bottom. Each primary duct also has a 100 NB drain plug with dummy nut.

The primary duct also acts as a walk way across the tower. Hence, handrails are provided on both sides along the duct.

3.2 SECONDARY DUCT

A Secondary duct is required to distribute hot water over small segments of the circular area which cannot be catered to by the Primary duct. This duct too is designed as a RCC channel but with a cast-in-situ slab on top.

The secondary duct too acts as a walk way. Hence, handrails are provided on both sides along the duct.

3.3 LATERAL PIPES

Lateral pipes are of PVC or other material as shown in the drawings. The pipes should be with Spigot ends so that couplers for jointing are avoided to the extent possible. Reducers, End plugs, etc. needed for the operation of the distribution system and as shown in the drawings shall be provided by the contractor. All the accessories shall be of the same rating as of the pipe (Class 3 to IS: 4985).

Lateral pipes shall have pre-fabricated holes at desired intervals (as shown in the drawing) for fixing of nozzles. No drilling will be permitted in pipes after these are installed/embedded in HW ducts.

Maximum diametrical tolerance of (+) 1 mm is allowed for the holes. And alignment of holes shall be within + 10 mm tolerance limit. Hence, it is suggested that the contractor make a suitable jig arrangement at ground level to achieve this requirement.

Nozzles should be fixed to the lateral pipes by bolting and tying with Polypropylene (PP) straps as shown in the drawings. In case of additional fastening with PP straps, the straps shall be capable of taking a minimum load of 30 Kg. Necessary accessories for fastening shall be of same material as of the strap. Bolts shall be of SS-316 material.

After installation, the system shall be rigid and leak proof. Care must be taken by the contractor while Lateral pipes are embedded in the side walls of the primary and secondary ducts to ensure that no leakage or failure occurs during commercial long-term operation.

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Pipe joints shall be rendered leak proof by proper application of gluing compound and riveting as shown in the drawings.

Alignment of lateral pipes shall be within the tolerance limits specified above for the pre-fabricated holes. All the nozzles shall be aligned to the direction of gravity. The levels of the pipes and nozzles shall be maintained to result in uniform distribution.

3.4 NOZZLES

The nozzles shall be of down-spray type in PP construction. The spray pattern shall be either circular or square with a minimum diameter of 900 mm.

The contractor shall offer a nozzle that achieves the spray pattern and diameter specified at a static head shown in thermal design calculations. The final choice of the nozzle shall be subject to acceptance by the Engineer-in-Charge.

The tolerance on nozzle opening size for discharge shall be limited to $\pm 1\%$ of that shown in the drawings. Contractor shall demonstrate the performance at 80%, 100% and 120% water loads at nozzle vendor premises using a properly designed test rig. The contractor shall submit testing facility details along with test procedure for review and acceptance before under taking the performance test and procurement or supply of nozzles.

Owner reserves the right to witness the nozzle testing at vendor works. Contractor shall submit the nozzle performance curves to the Owner for review and final acceptance of the proposed nozzle type to achieve the performance envisaged in designs and drawings.

In case of any deficiency is found in nozzle performance at a later stage, the Contractor shall provide additional nozzles or nozzles of a better type without any additional cost to the Owner to meet the design requirements.

In case nozzles comprise of two or more parts, assembly of the same shall be either by threaded connection or SS 304 bolting. The Contractor shall submit a sketch/drawing of the nozzle and its fixing arrangement, including two sample pieces along with his offer.

3.5 HOT WATER PIPING

The MS hot water riser piping shall be connected to the Owner's hot water header pipe at the Terminal Point as shown in the drawing. The end connection shall be of welded type. If the terminal points of owner's header pipes are not ready, all the open ends of the pipes shall be covered with polythene sheets to prevent corrosion.

Steel pipes shall be made either by ERW/SAW methods. Steel pipes shall conform to IS: 1239 (Medium grade) and IS: 3589 (Fe 410 grade) as the case may be. Steel plates for pipes shall conform to IS: 2062. For pipe sizes up to 300 NB, seamless long radius elbows shall be used unless otherwise specified. For pipe sizes above 300 NB, mitre bends shall be used.

The Contractor shall provide the necessary civil & structural works, if required for all the independent foundations, thrust blocks, etc supporting the hot water pipe. Painting shall be as specified elsewhere in this document.



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3.5.1 Butterfly Valves

Butterfly Valves shall be electrically operated Double flanged type meeting the requirements of AWWA C – 504 or BS: 5155. Necessary cabling for actuators and limit switches, etc shall be provided by the Contractor up to a common Junction Box located near the Staircase.

POD (Proof of Design) Test	: AWWA C – 504
Operating Fluid	: Water at 45 to 50 deg. C
Design Pressure	: 5.0 Kg./Sq.cm
Max. Differential Pressure	: 5.0 Kg./Sq.cm.
Head loss coefficient	: Max. 0.25
Body	: Cast Iron to IS: 210 Grade FG 260 'OR' Fabricated steel confirms to IS:2062/IS:2002
Shaft	: Stainless Steel to AISI 304
Bearing type	: Self-lubricated type
Disc seat	: Nitrile Rubber
Body Seat	: SS 316
Internal Hardware	: SS 304
External Hardware	: High Tensile Steel
Fasteners	: SS 304
Gland Packing	: Teflon
Gaskets, Rings, etc.	: Nitrile Rubber
Accessories	: 2 Nos. of 2NO + 2NC Limit Switches 'OPEN' & 'CLOSE'.

All the butterfly valves shall be complete with graduated position indicator, arrow indicating the flow direction, actuators, limit switches, etc. The valves shall be suitable for erection in any position (Horizontal / Vertical, etc.). The operating mechanism shall be mounted directly on or supported from valve body. Actuator specifications shall be as specified elsewhere in this document.

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All the butterfly valves shall be provided with hand wheel. Butterfly valves of size 350 NB and above shall be provided with reduction gear units. Valves shall close in clockwise direction. The hand controls shall be dimensioned to guarantee an easy manoeuvre under most severe conditions. The hand controls shall be provided with locking systems to avoid the disk assuming a not desired position during operation. The pulling force required on the hand wheel-rim shall not exceed 30 Kg. when operating the valve under full flow and operating pressure, in case of failure of actuator. The reduction units shall be watertight, complete with lubrication and position indicator.

3.5.1.1 Flanges

For valves designed as per AWWA C-504, flanges shall conform to ANSI B16.1 Class 150 for CI valves and AWWA C-207 Class D for fabricated steel valves. The counter flanges shall conform to AWWA C-207 Class D.

For valves designed as per BS: 5155 the flanges shall be as per BS: 4504. All the flanges shall be of slip-on and flat-face type. Flanges shall be fabricated from steel plates conforming to IS: 2062.

3.5.2 Ball Valves:

Ball valves are envisaged mainly for flow measurement ports. These valves shall conform to IS: 9890 and are of threaded type.

Pattern and Construction	: Full bore in single piece
Nominal size	: 150 NB
Design pressure	: 6 kg/sq.cm
Material of construction	: Carbon Steel Valves to IS: 9890

3.5.3 Sluice Gate (if applicable)

The sluice gate shall be of circular opening conforming to IS: 3042 Class – 1, with rising spindle. The materials of construction of the gates shall be as follows:

Frame and Door	: CI Grade 20 of IS: 210 with an inside coating of Epoxy coal tar.
Face, seat rings, trim and Spindle Nut	: SS 316
Spindles, bolts and nuts	: Hot dip double galvanized MS

Each sluice gate shall be furnished complete with extension spindle through extra-strong pipe of required length connected to the floor-stand through stem coupling. The floor-stand shall be provided on concrete floor of the drain box. Each gate shall be furnished with bell-bottom base and

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shall 815 mm high, provided with an indicator and open/close positions clearly marked on the stand. The floor-stand shall be furnished with 450 mm diameter hand wheel and wheel-stem coupling to suit the sluice extension pipe.

3.5.4 Miscellaneous

Each hot water header shall have 3 Nos. of 150 NB, 200 mm long MSHDG stubs with threaded or flanged ends (depending on valve ends) for measurement of water flow with Pitot tube. The location of these stubs shall be at a location on the header piping where at least a straight length of 10D on upstream side and 5D on downstream side is available.

Each stub shall be fitted with 150 NB Ball Valve for isolation purpose. All necessary bolts, washers, nuts shall be of MSHDG.

Each hot water header shall have one number stub for pressure gauge with isolation valve and one thermowell for temperature measurement.

3.6 CONSTRUCTION FEATURES OF M.S. PIPING:

3.6.1 End Preparation, Cutting, etc.

For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting. Socket weld preparation shall be saw/machine cut. All the welding electrodes and other requirements for welding, including any special material, shall be arranged by the contractor.

For tees, laterals, mitre bends and other irregular details, template shall be used for accurate cutting.

3.6.2 General Instructions for Piping Construction

While erecting the field run pipes, the contractor shall check the accessibility of valves, instrument tapping points and maintain minimum head room requirement and other necessary clearances from the adjoining work areas. Irrespective of whether mentioned in the drawings or not, all pipelines shall be given proper slope towards the drain point.

3.6.3 Welding:

- Before welding the ends shall be cleaned by wire-brushing, filing or grinding.
- Welding of piping shall be done by certified welders. Welders' qualification shall be as required by ASME Section-IX. Welding at any joint should be completed in one go.
- Welding under this specification shall be done by a process approved by the Engineer-in-Charge.
- Automatic or semi-automatic welding shall be done only with the specific approval of the Engineer-in-Charge.
- As far as possible welding shall be carried out in flat position. In case that is not possible, welding shall be done in a position as close as to the flat position as possible.

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- f. Downward technique is not allowed in the welding of pipes in horizontal position, unless permitted by the Engineer-in-Charge.
- g. Combination of welding processes or usage of electrode of different classes or 'makes' in a particular joint shall be done after the welding procedure has been duly qualified and approved by the Engineer-in-Charge.
- h. Welding carried out in ambient temperature of 50°C or below shall be heat-treated.

3.6.4 Alignment & Spacing

- a. The pipes joined by welding shall be aligned correctly within the existing tolerance on diameters, wall thickness & out of roundness, which shall be preserved during welding. All flange facings shall be true and perpendicular to the axis of the pipe with bolt holes being off centre, unless different orientations are shown in drawing to match some equipment connections.
- b. Components to be welded shall be aligned and spaced.
- c. Root opening shall be 1 mm to 2 mm for wall thickness of 2.4 mm or under and for all thicknesses in oxy-acetylene welding. For 2.4 mm and above, root opening shall be 2 mm to 3 mm.
- d. Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form a part of final welding these shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.
- e. Electrode size for tack welding shall be selected depending upon the root opening.
- f. Tack welding should be equally spaced as follows:

For 65 NB pipe and smaller	: 2 tacks
For 80 NB to 300 NB pipe	: 4 tacks
For 350 NB & larger pipes	: 6 tacks

3.6.5 Welding Technique

- a. Root pass shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
- b. Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxy-acetylene welding is recommended.
- c. The root pass of butt-joints shall be so as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.
- d. Each pass shall be cleared to be made free of slag before the next pass is deposited.
- e. In case of deviation from the welding process and electrodes as specified, the contractor shall seek the approval of Engineer-in-Charge before implementing the change.
- f. On completion of each run, craters, weld irregularities, slag, etc. shall be removed by grinding or chipping.
- g. During the process of welding, all movements, shocks, vibrations or stresses shall be carefully avoided in order to prevent weld cracks.
- h. Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG (3.25 mm). At least two passes shall be made on socket weld.

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4.0 BASIN

Basin is divided into two equal parts by a diametrical partition wall. Each NDCT basin compartment shall be provided with a cold water outlet and a drain sump at the opposite ends. A peripheral drain shall be provided with a minimum floor slope of 1:400 towards the drain sump for easy cleaning of the basin. The basin floor itself, in turn will be provided with a slope of 1:500 towards the peripheral drain.

Sludge will be removed using portable pumps, which shall be supplied by the contractor. The Contractor shall make all provisions such as platforms with handrails, discharge piping up to terminal point, etc. for smooth operation of these pumps. Rungs shall be provided up to the bottom of sump in each compartment for maintenance of valves and pumps.

5.0 COLD WATER CHANNEL

Cold water outlet near cooling tower is partitioned into two parts. Each part of cold water outlet shall have Screens and Stop Log Gates as shown in the drawings. Guide frames of Screens and Gates shall be interchangeable.

To obtain proper alignment of the guide channels, a bigger slot will be left in the concrete and after fixing the channels in position the grouting of these channels will be done by secondary grout/concrete so that fixtures do not get disturbed.

Monorails with push trolleys, chain pulley blocks and hooks shall be provided for handling of gates and screens,. The structural arrangement required for the monorails shall also be provided by the contractor as per the approved drawings.

A walkway with handrails shall be provided across the outlet for easy operation of gates and screens. Both the compartments of cold water outlet shall be combined into a gravity channel at the end of the partition wall as shown in the drawings. The combined cold water outlet shall be covered with RCC cast-in-situ slab up to terminal point. Termination of cold water outlet shall be done with PVC water stopper.

5.1 SCREEN

Mesh	: SS 304 L
Mesh Size	: 10 mm x 10 mm to IS: 2405, Part 1
Supporting Frame	: MSHDG with SS 304 L slide parts.
Guide Frame (Embedded in Concrete)	: MSHDG with SS 304 L sealing surface
Trash Tray	: MSHDG

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Fasteners : SS 316

Screens shall freely move inside the structural framework embedded in the concrete walls of the open channel. Screens provided in the outlet channel shall have a trash tray incorporated on the upstream side of the bottom edge of the screen to catch any debris falling down the screen during removal.

5.2 STOP LOG GATE

Standard : IS: 5620

Guide frame (Embedded in Concrete) : MSHDG with SS 316 L sealing surface

Gate (including supporting frame) : IS 2062 Gr. A

Slide plates of gate : MSHDG (min. 8 thk)

Slide Seal : EPDM Musical note to IS: 11855

Bottom Seal : EPDM to IS: 11855

Painting : Specified elsewhere

Fasteners : SS 316

Slide gate constructed in hot double-dip galvanized structural steel sections shall be furnished as per the drawings to be given during execution. The gate shall move freely inside a structural framework embedded in the concrete walls of the open channel. The gates shall have a continuous bearing under compression all around the opening ensuring no leakage.

6.0 ACCESS

6.1 STAIR CASE

All stair cases shall be 'Dog Legged'. The minimum clear width of the stairways and platforms shall be 1000 mm. Minimum clear headroom of 2.5 m shall be maintained over platforms and walkways.

6.2 ACCESS DOORS

The doors shall be of single leaf – double skin type and of 2.1 m (H) x 1.2 m (W) size fabricated from 1.25 mm thick MSHDG steel construction. Painting shall be carried out as specified elsewhere. Alternatively, the Contractor may offer these doors in FRP material as well.

6.3 CAGE LADDER

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The cage ladder shall conform to IS: 3696. The ladders shall be min. 600 mm wide and made of hot double dip galvanized 75 mm x 6 mm thick flats with 20 mm diameter rungs at 300 mm centres with stays at every 1.75 m connected to the wall. The ladder shall be provided with a hot double dip galvanized MS cage consisting of 50 mm x 6 mm straps at 800 mm centres with min. five (5) Nos. 50 mm x 6 mm vertical cage flats throughout the complete length of the ladders. Intermediate landing platforms with handrails, as required and/or as shown in the drawings shall be provided.

6.4 WALKWAYS

Walkways shall be min. 1000 mm wide and shall have min. 2.1 m headroom, unless otherwise specified. All walkways shall have safety handrail of min. 1.2 m height on both sides.

6.5 RUNGS

MSHDG rungs of 25 mm diameter shall be embedded in RCC walls wherever required. Each rung shall be 450 mm wide x 150 mm above wall face unless otherwise specified.

7.0 MATERIAL HANDLING FACILITIES

7.1 AT TOP OF SHELL

During maintenance of the tower, to lift the materials like lighting poles, aviation lights, welding machine etc., from ground to the top of the tower, material handling provision to be made at the top of the tower. MSHDG plates of size 300 x 300 x 20 mm shall be embedded in the wall, flush with the outside concrete surface at 1 m C/C on the shell circumference at the top most platform level. Each plate shall have four tapped holes with nuts welded to the back of each hole (for having extra-long thread engagement) for fixing bolts later. The drilled and tapped holes and nuts shall be suitable for 20 mm diameter bolts. Care shall be taken to prevent entry of concrete into the nut and tapped holes. This arrangement is to support a swivelling lifting arm to hoist a load of 1000 kg.

7.1.1 PORTABLE ROTATING TYPE LIFTING ARM

Lifting arms including swivelling brackets, pins, etc. complete shall be provided along with 250 mm diameter CS pulleys. It shall be possible to easily erect/dismantle this arrangement as and when required. All structural steel sections, brackets and inserts such as bolts, nuts, plates, etc., shall be of MS hot dip galvanized.

7.2 FOR SCREEN AND SLIDE GATE IN COLD WATER CHANNEL

Monorail beam at sufficient height shall be provided. A hand operated chain pulley block with traveling trolley of capacity not less than 125% weight of slide gate shall be provided. All other accessories for this system shall also be designed for the same load. Monorails shall be extended outside the cold water channel to lift/lower the equipment from/to the ground level.

Life : Not less than 20 years

All CI parts : Grade FG260 of IS: 210

Chain pulley blocks : IS: 3832, Class 2 duty

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Hand operating chain	: IS: 2429 grade 30 pitched & polished
Load Chain	: IS: 3109 grade 40
Hook	: IS: 7847
MOC of hook 7.1 (b) of IS: 3815	: High tensile steel and heat treated as per Clause
Wire ropes/slings	: IS: 2266

8.0 HARDWARE

All the hardware immersed in water or in direct contact with water/water spray shall be of SS 316, unless otherwise specified. The hardware not in contact with water or moisture shall be of MSHDG, unless otherwise specified.

10.0 TESTS:

The contractor shall submit detailed QAPs for approval. Typical QAPs are given elsewhere in this document.

10.1 FILL

10.1.1 Material Test

For plastic fills and drift eliminators impact tests shall be done as per ASTM-D-256 and flammability tests as per ASTM-D-635. Density and Vicat softening tests shall also be done. The contractor shall submit test certificates from approved third party laboratories for approval by the owner. All tests on Fills & Drift Eliminators shall conform to CTI STD-136.

10.1.1.1 UV Test for Plastic fills

UV test shall be done as per ISO-4892. Impact test shall be done before and after UV test. Test certificate from approved third party laboratories shall be submitted for approval by the owner.

10.1.2 Dimensional Test & Load Test on Fill

Dimensional accuracy and material thickness will be checked randomly at site. Load Test shall be done on a mock fill assembly. Both the tests will be done in presence of Engineer-in-Charge.

10.2 BUTTERFLY VALVES

Butterfly valves shall meet the proof of Design test and Disc strength test confirm to AWWA-C-504. Seat leak test shall be done in both directions. In case of fabricated valves, UV test on plates 20 mm or above thickness for body, disc and shaft shall be done. Radiography test on 100% butt welds and 10% DPT on fillet welds shall be done in presence of Engineer-in-Charge.

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10.3 GATE/BALL VALVES

Material test, DPT for 100% butt welds and 10% fillet welds, assembly fit up and hydraulic test shall be done and certificates of same to be submitted for approval.

10.4 SLIDE/STOP LOG GATE

Material and DPT for 100% butt welds and 10% fillet welds shall be done and certificates of the same shall be submitted for approval. Assembly fit up, Dimensional accuracy and Leak tight test shall be done at site.

10.5 CHAIN PULLEY BLOCKS

Test certificates of material and DTP shall be submitted for approval. Full load test and 25% overload test shall be carried out with all motions and safety features at site.

10.6 HOT WATER PIPES

Certificates of material and welder qualification shall be submitted for approval. Assembly fit up, dimensional accuracy, DPT and NDT (if required) shall be done at site.

10.7 SCREENS

Certificates of material and DPT shall be submitted for approval. Assembly fit-up test and dimensional accuracy shall be done at site.

11.0 VENDORS LIST

S. No	DESCRIPTION	VENDORS
1.	Testing Agency for Fills & D/E	Shriram Labs, New Delhi / CIPET, CHENNAI
2.	Butterfly Valves	AUDCO / FOURESS / KEYSTONE / IL / INTER VALVE/ KIRLOSKAR / DYNAMIC
3.	Structural Steel	SAIL / TATA / JINDAL / VIZAG STEEL
4.	PVC Pipes	SUPREME / FINOLEX / PRINCE
5.	Push Trolley, Chain Pulley Block, Hook & Chain	WMI / INDEF



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6.	Red Oxide Zinc Chromate Primer	'APCOMIN' OF ASIAN PAINTS / BISON UNIVERSAL OF BRITISH PAINTS / '3100' OF JANSON & NICHOLSON / SYNTHETIC ZINC CHROMATE OF SHALIMAR PAINTS
7.	Epoxy Primer	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
8.	Epoxy Paint	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
9.	Aviation Obstruction Lights	BINOY / INSTAPOW / AVAIDS
10.	PVC Fills & D/Es	CONTRACTOR'S OWN MAKE / MM AQUA
11.	SS Weld / FRP Mesh	CONTRACTOR'S OWN MAKE / WIRE NETTING INDUSTRIES / JEETMUL JAICHANDLAL / NBC Weld Mesh
12.	Nozzles	CONTRACTOR'S OWN MAKE / VULQUA

This vendor list is tentative and shall be subject to CUSTOMER approval during detailed engineering.



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SECTION-C: ELECTRICAL & INSTRUMENTATION

1.0 AVIATION OBSTRUCTION LIGHTING SYSTEM (AOLS)

The aviation obstruction lights shall meet the recommendations of ICAO and all the requirement of Director General of Civil Aviation, India and FAA guidelines in general.

Aviation lights shall be fixed on the top of NDCTs. Type of fixtures shall be as listed below.

Tower height	Type of Light	Description
$\leq 150\text{m}$	Type B, Medium Intensity	Red flashing light with directional intensity of $2000\text{cd} \pm 25\%$. Flash frequency shall be in the range of 20 to 60 per minute
$> 150\text{m}$	Type A, High Intensity	White flashing light with directional intensity of $200000\text{cd} \pm 25\%$. Flash frequency shall be in the range of 40 to 60 per minute

The number of fixtures shall be as given under.

Top diameter	No. of fixtures
$\leq 20\text{ ft}$	3
$20\text{ ft} < \leq 100\text{ft}$	4
$100\text{ ft} < \leq 200\text{ft}$	6
$> 200\text{ ft}$	8

All flashing lights shall flash simultaneously. Low and Medium intensity lights, if applicable should be operated only in night times. High intensity lights should be operated in day time with full intensity (2,00,000 Cd), during twilight times with 20,000 Cd and in night times operates with 2,000Cd intensity. Installation and setting angles for high intensity lights shall conform to table no.6.2 of ICAO / FAA guidelines.

1.1 AVIATION OBSTRUCTION LIGHTS (AOL)

Each AOL fixture shall have 100% standby light i.e. twin type. In case of failure of any operating light, the standby should be activated automatically with auto changeover facility giving hooter feedback. AOL shall be LED type conforming to IP-65 grade protection class. High intensity lights shall have

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intensity step changers. The control panel for the AOLs shall be mounted near the main distribution board under the staircase.

1.2 Photoelectric light detectors shall be furnished and installed near NDCTs to monitor the north sky. The detector shall cause the control unit to energize the aviation lighting system with the north sky illuminance. The lighting system may be energized during short periods of decreasing illumination due to abrupt periods of shadow during daylight hours, but shall not be de-energized as the result of short periods of increasing illumination levels due to lighting flashes or stray light sources when overall illumination level is such that the system is operating.

1.3 Temporary warning lights shall be installed during construction and these shall be located above the top most point of the obstruction and shall be shifted as construction progresses. These lights need to be installed only after the level of obstruction is greater than 50 m above ground. Temporary warning lights shall be of four fixtures each with not less than 10 candelas of red light. Power for operation of the temporary lights shall be obtained from the construction power system. Electrical circuits and cables for these lights shall be furnished, installed and maintained by the Contractor during the construction / erection period. These lights shall be operated right from sunset to sunrise.

1.4 The contractor shall provide hand railing around the beacon platforms, if applicable for attending to any maintenance work.

1.5 The AOLs shall be adequately secured to the handrails / parapet wall of the top platform against wind forces.

1.6 All cables shall be supplied and fixed as per relevant IS codes, clamped at intervals of 1000 mm by the side of the ladder. The cables shall be PVC insulated and PVC sheathed / armoured copper conductor of 650/1100V grade heavy duty conforming to IS: 1554 Part – I (latest revision). The cable shall be subject to Owner's approval.

1.7 The contractor shall install weatherproof terminal boxes with cable glands on top of the NDCTs at a location close to the AOLs. Suitable pull boxes shall be provided at convenient locations.

1.8 There will be two incomers – one main and the other stand-by. Automatic changeover facility with manual option shall be provided in case of failure of main incomer. Standby incomer will be disconnected once the main incomer is restored with suitable delay. A 0-30 second delay timer should be provided to prevent change over taking place for very short-term failure. A16 ampere or higher rating circuit for AOLs shall be provided. The aviation warning lights shall be controlled by photoelectric cell facing north sky through contractor. Auto manual operation selector switch shall be provided for 'ON' and 'OFF' operations. A wall mounted, sheet steel enclosed type Distribution Board (DB) shall be supplied and installed at the ground level for below the staircase. It shall have arrangement to receive Owner's PVC cable (size to be intimated later) and shall have an isolating switch and separate switch fuse circuits for feeding the aviation lights. The DB shall be outdoor type dust and vermin proof and shall have a sheet steel thickness of not less than 2 mm and shall have a proper gasket with removable gland plates at top and bottom. The DB shall also house the automatic switching arrangement described above. The board shall be dead front type; all equipment shall be mounted on auxiliary door. The DB shall be provided with two separate and distinct Grounding terminals. The cables and cabling between distribution board, flashing control unit and AOL fixtures shall be in Contractor's scope.

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1.9 Lighting fixtures, conduits, junction boxes, etc., shall be properly earthed using GI wire of 14 SWG. Earth wire will run along the entire length of the cable between the fixtures and DB where it will be connected to the earth.

1.10 Contractor's scope includes supply, installation, commissioning and maintenance of the complete AOL system and its cabling until the NDCTs are taken over by the Owner. The scope shall also include the associated civil works.

1.11 AOL system shall be test operated by the Contractor for not less than 12 months from the date of trial commissioning. Equipment and work that fails during the test period shall be repaired or replaced at the option of the Engineer-in-Charge. Upon any failure in this system during the test period, a new test period of 12 months will be required after repair or replacement of the equipment that has failed.

1.12 POWER RECEPTACLES

32A TPNE industrial type switch-socket outlet(s) shall be provided on the top peripheral platform and on landing platforms, if applicable as specified elsewhere.

2.0 EARTHING AND LIGHTNING PROTECTION

The Contractor's scope of supply for lightning protection includes complete system required as per IS: 2309 from air termination rods to earth mat and electrodes, whether specifically mentioned herein or not.

Grounding system shall confirm to IS: 3043. Each air terminator shall be connected to individual earth-pits through individual down conductors and earth conductors. Apart from the above, a coronal band and an earth mat shall be provided for each NDCT. Depending on the number of earth pits, four shall have test links and two shall have pigtails for connecting to main plant earth grid. All structures and equipment (even the one which are not supplied by the contractor but are in the cooling tower area) shall be connected by minimum two parallel conductors to nearest down/earth conductors.

2.1 Material of Construction

Material of conductors used above Ground level shall be of GI with zinc deposition of minimum 610 gm/m². All buried conductors are of MS round bars of min. 40 mm diameter.

a.	Air terminator	: 2 m long, 20 dia. Copper rod with pointed tip
b.	Coronal Band	: 75 x 10 thk GI flat
c.	Down Conductor	: 75 x 10 thk GI flat
d.	Earth Conductor	: 40 dia MS rod
e.	Earth Mat	: 40 dia MS rod
f.	Earth Electrode	: 3 m long, 40 dia MS rod
g.	Grounding for Columns & Structures	: 50 x 6 thk. GI flat
h.	Handrails & Steel structures	: 40 x 3 thk. GI flat

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- i. Grounding for Distribution boards & Control Panels, etc. : 40 x 3 thk. GI flat
- j. Grounding for Power outlets
- & Lighting Fixtures : 14 SWG GI wire

2.2 AIR TERMINATOR

Tip of air terminator shall be pointed and at least 1.2 m above top of cooling tower. Air terminator shall be clamped with heavy-duty GI clamps at a minimum of 3 points to the structure. Air terminators shall be connected to down conductor and coronal band by use of pressure type fittings.

2.3 CORONAL BAND

Cooling tower shall have a coronal band connecting all air terminators provided at the top of the cooling tower. It shall be clamped to structure at 1000 C/C intervals all around.

2.4 DOWN CONDUCTOR

Down conductors shall be connected to Air terminators via the Coronal band at the top of the cooling tower and to the earth conductor at 300 mm above FGL through a test point at 1.2 m above grade. These conductors shall be continuous as far as possible. Intermediate breaks if any, shall be welded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable. These conductors shall be embedded in the outer surface of the concrete shell and diagonal columns with a minimum cover of 50 mm. These shall come out of the shell at the top of the cooling tower and at the ring beam level.

Ladders shall be electrically connected to the down conductors at top, middle and bottom by bolted connections.

2.4. TEST LINK

Test link shall be of 50 x 6 thk GI flat with electroplated bolts, nuts and washers. Test link shall be installed in a GI box fixed on the outside surface of the raker column.

2.5 EARTH CONDUCTOR

Earth Conductor shall be connected to down conductor, earth mat and earth pit by welding. Earth conductor shall be taken through approx. 1.3 m long, 100 NB AC pipe filled with PCC (1:3:6).

2.6 EARTH MAT

Cooling tower shall have a circular earth mat of diameter at least 12 m more than the cooling tower sill diameter and laid at 1000 mm below the ground. All the joints shall be of welded type.

2.7 EARTH PIT

Earth Pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600 mm. Earth Pits shall be treated with salt and charcoal, in case average resistance of soil is more than 20 ohm-meters.

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2.8 CLAMPS & ANCHORS:

All connections, clamps, anchors, etc. of the lightning protection system shall be made of GI fittings. All joints, unless otherwise specified shall be clamped or bolted (min. 2 Nos. of bolts) to form high pressure contact for a connection of adequate current carrying capacity and mechanical strength.

2.9 VERTICAL AND HORIZONTAL REINFORCING BARS

All vertical reinforcing bars at the top and the bottom portion of the cooling tower shall be electrically connected to the nearest horizontal reinforcing bar and these bars shall in turn be connected to the down conductors. At locations where vertical reinforcing bar is spliced, each of the spliced bar shall be electrically connected to at least one horizontal reinforcing bar which in turn shall be electrically connected to the down conductor. These electrical connections shall be made by winding tightly with not less than five (5) wrapped turns of 14 SWG GI wire.

2.10 TEMPORARY LIGHTNING PROTECTION

Temporary arrangement for lightning protection during construction shall be maintained by connecting the reinforcement bars to two Grounding conductors of minimum size 50 x 6 thk. Temporary protection shall be provided even after the completion of the tower till such time that the permanent air termination rods and various conductors, etc. are installed.

3.0 INSTRUMENTATION

3.1 PRIMARY INSTRUMENTS

a. Thermowell

Thermowell shall be of one piece solid bore type in SS 316 and of step-less tapered design as per ASME PTC 19.3.

b. Temperature Gauge

Range : 0° C – 50° C (linear 270° arc in metric units)

Accuracy : + 1% of span

Dial size : 150 mm

Sensing element : Mercury in steel with SS Bulb and Capillary

Body material : Die-cast aluminium

Protection : IP55

Zero / Span adjustment : Required

Accessories : SS Thermowell



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c. Pressure Gauge

Range : 0 – 5 kg/sq.cm (linear 270° arc in metric units)

Accuracy : + 1% of span

Dial size : 150 mm

Sensing element : Bourdon/Diaphragm/Bellow of SS 316

Body material : Die-cast aluminium

Protection : IP55

Zero / Span adjustment : Required

Accessories : Blow out disc, Siphon, Snubber, Pulsation Dampener, Isolation Valve

3.2 SECONDARY INSTRUMENTS

RTD

Range : 0° C – 50° C

Characteristic : Linear with temperature (within + ½ % of top range value)

Type : Metal sheathed, ceramic packed

Standard : DIN 43670

No. of Elements: Duplex – 4 wire

Housing : IP 55 / Die-cast Aluminium

Calibration and accuracy: As per Class A of DIN 43760

Accessories : Spring loaded for positive contact with the well

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SCHEDULE – II: PROCEDURE FOR PERFORMANCE TEST

The Contractor is required to comply with the Thermal Design Calculations, GA Drawing and Design Basis Report enclosed with this specification and stand guarantee for thermal performance of the NDCTs as per the specification requirements.

Once the construction and erection works are completed by the Contractor, he shall undertake trial commissioning of the NDCTs after notifying the Owner/Purchaser. The Owner shall provide the necessary water flow / heat load to the NDCTs for trial commissioning.

After successful trial commissioning to the satisfaction of the Owner/Purchaser, the Contractor shall carry out Performance Guarantee Test on the NDCTs as per the schedule agreed to demonstrate the thermal performance during conditions close to the design.

1.0 SCOPE AND PURPOSE

1.1 Scope

This Performance Test Procedure covers the determination of the water-cooling capacity of the Natural Draught Cooling Tower.

1.2 Purpose

This note gives an outline of procedure for the performance test. For full details, the tender documents and other associated documents as well as codes mentioned below may be referred.

1.3 Flexibility

It is recognized that the data limitations specified throughout this test procedure represent ideal conditions, which are not available most of the times the tests are performed. In such cases actual conditions may be used provided written consent is obtained from the official representative of the manufacturer and the Engineer-in-Charge.

1.4 Scope of Test

Acceptance test shall cover the determination of the thermal capability and verification of the guarantee parameters of the cooling tower constructed for the project.

1.5 Conduct of the Test

a. Test shall be conducted by accredited representatives of the Contractor in the presence of the Owner/Purchaser. The Contractor shall be given permission to inspect the tower in advance. Owner's/Purchaser's representatives shall witness all phases of the test and record the data jointly with the Contractor.

b. The responsibility for conducting the test will be with the Contractor.

c. All instruments required for the Performance test and their calibration as per codes will be the responsibility of the Contractor.

d. Calibration of the test instruments will be carried out by an approved independent Govt. agency. The calibration of the equipment should not be older than six months before the test and should be valid at the time of the test.

e. Performance curves

Performance curves for 80%, 90%, 100%, 110% and 120% of design water flow are enclosed. The performance of cooling tower during the test shall be compared with the performance possible/expected on the basis of these curves.

1.6 Codes

The performance test will be generally as per CTI Code ATC-105 or BS4485 Part-II. The following checks should be done before the test.



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- a. Water distribution system shall be essentially clear and free of foreign materials, which may impede the normal water flow. All the nozzles should be in place and clean so that the water distribution is good and as per design.
- b. Fill shall be essentially free of foreign materials such as oil, tar, scale, silt or algae.
- c. Water level in cold-water basin shall be as close as possible to normal operating level and should be maintained substantially constant.
- d. Make up water and blow down should be stopped during the test period. In case it is not possible to stop the make-up water, the correction for the same will be applied as per code.

2.0 CONDITIONS OF THE TEST

Every effort should be made to conduct the test when the conditions are very close to the design. At the time of the test, the tower shall be in good operating condition. During the test, steady state and calm conditions shall prevail for the various parameters involved. Tentatively, the duration of the test shall be 4 hours. During this period, to avoid uncertainties introduced by make-up water and purge water, these will be shut off and the duration modified accordingly to maintain the concentrations of dissolved solids, etc. The station power load should be maintained at its near maximum.

The design parameters of the cooling tower are as follows:

Parameter	Unit	Design Point	Performance Range
Circulating water flow rate	m ³ /hr		±20%
Cooling Range	°C		±20%
Ambient Wet-bulb Temp.	°C		±8.5
Ambient Relative Humidity	%		40% to 100%
Re-cooled Water Temp.	°C		To be checked with the Performance Curves
Wind Velocity	km/hr		0 to 5

3.0 VARIATION IN THE RANGE OF PARAMETERS

During the test, the water-flow, range and heat load shall not vary by more than 5%, and shall generally remain within the limits specified in the table above.

The total dissolved solids in circulating water shall remain within design limits. Instantaneous air temperature readings may fluctuate, but variation in averages during the test period shall not exceed the following:

- a. Wet bulb temperature : 1°C
- b. Dry bulb temperature : 2.5°C

4.0 INSTRUMENTS FOR MEASUREMENT

All the Instruments to be used shall be calibrated.

- a. Water flow: The circulating water flow should be measured using a Pitot Tube - Manometer assembly. The flow through the tower should be measured in the hot water header/riser(s) based on

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the provisions made by taking either two traverses at 90° if sufficient straight length is available or three traverses at 120° if adequate straight length is not available.

b. Hot Water Temp: The hot water temperatures should be measured by using RTDs with 0.05°C least count. The measurement should be done in the hot water header / riser based on the provisions made.

c. Cold Water Temp: The cold water temperature should be measured by using RTDs with 0.05°C least count. The measurement should be done in the cold-water outlet.

d. Relative Humidity: The Relative Humidity should be derived from the measurement of wet bulb and dry bulb temperatures.

Wet Bulb Temperature (WBT): WBT should be measured using a Mechanically Aspirated Psychrometer with its bulb continuously kept wet by a wick. The air velocity over the temperature sensitive element should be maintained between 3 and 5.4 meters/sec. The thermometers for wet bulb and dry bulb shall be Mercury in glass type with a least count of 0.05°C. The measurement of WBT should be made at about 1.5 to 2.0 m above the sill level and between 15 and 100 meters to wind ward of the tower and equally spread along a line substantially bracketing the flow to the tower.

Readings should be taken at about 5 minute intervals consecutively at various stations. Both the temperatures should be measured in the shade.

The ambient wind velocity should be measured using a rotating cup / vane type anemometer. Calibration of the instrument before the test is necessary. Measurement should be made in an open and unobstructed location upwind of the tower and beyond the influence of inlet air approach velocity.

Location may be selected within 30 m of and to the windward direction of the tower at a point 1.5 to 2 m above the basin curb elevation. This location shall be subject to mutual agreement. Care shall be taken that the wind velocities and direction recorded are the true reflection of the conditions affecting the tower. Wind direction should be recorded with the help of the compass and the tower orientation.

5.0 PROCEDURE FOR THE PERFORMANCE TEST

Tentatively, the test should be conducted for a 4 hour duration and out of this, an hour will be selected which is considered to be of most stable conditions (The test may be terminated earlier in case it is found that the conditions are quite stable for at least one hour duration before the 4 hour period). The average readings will be taken at 10 min. intervals.

The hour when the conditions are most stable shall be considered for the test readings. The measurement tolerance shall be as per codes. As already mentioned the make-up water and purge water will be stopped during the test to avoid uncertainties. However if it is not possible to stop the make-up and purge water, suitable correction shall be applied as per CTI / BS codes.

6.0 FREQUENCY OF OBSERVATIONS

Readings shall be taken at the regular intervals and recorded in the units and to the number of significant digits as shown in the following table:

Measurement	Unit	Min. nos. per hour	Record to nearest
WBT	°C	12	0.1
CWT	°C	12	0.1
HWT	°C	12	0.1
Wind Velocity	km/hr	6	0.1
Water Flow	m ³ /hr	3	1

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One full Pitot tube traverse readings will be taken prior to conducting the actual test. During the test a minimum of three centre point readings will be taken to verify the flow.

7.0 COMPUTATION OF THE RESULTS

7.1 Computation of Water Flow

The water flow of each diameter traversed shall be determined separately by graphical integration method. The curves shall be plotted with radius against velocity on millimetre graph paper on large scale (not less than 1:5) to minimize computational error. The water flow calculation shall be as per formulae given in CTI Code ATC-105.

The average flow through all the diameters is the calculated flow through the pipe.

7.2 Calculations of the Tower Performance

7.2.1 Determination of predicted cold water temperature

The predicted cold-water temperatures (CWTs) shall be read from the performance curves for 80% to 120% of the rated flow (as the case may be) at the test wet-bulb temperature with range and relative humidity as varying parameters. A first cross-plot is drawn at each of the flow rates and a set of curves are drawn between predicted CWT and relative humidity with range as a parameter.

Scribe the test RH on the above cross-plot to read various predicted CWTs at different ranges for each of the water flow rates. Draw a second plot with between predicted CWTs and different ranges for each of the water flow rates.

Scribe the test range on the above cross-plot to read various predicted CWTs for each of the water flow rates. Draw a third cross-plot between predicted CWTs and water flow rates at the test WBT, range and relative humidity.

Enter the test CWT on the above cross-plot to read the predicted water flow rate.

7.2.2 Determination of Tower Capability

Tower capability should be calculated using the following formula, which is as per ATC-105:

Capability = Test Water Flow Rate (measured using the Pitot Tube)

Predicted Water Flow Rate (determined from the cross-plots)

7.2.3 Deviation in Guaranteed CWT

The tower capability calculated as above shall be used for determining the deviation in design CWT as per the procedure given in Appendix-M of CTI Code ATC-105.

The allowable tolerance in design CWT shall be subtracted from the above deviation determined as per ATC-105 to arrive at the deviation in guaranteed CWT.

7.2.3 Acceptance Criteria

If the deviation in guaranteed CWT equals zero (after subtracting the allowable tolerance), the tower is deemed to have met the guaranteed conditions.

7.3 Accuracy

To account for the errors in measurements, a tolerance of 0.3°C shall be allowed while determining the deviation in guaranteed CWT as above.

8.0 ARRANGEMENTS TO BE MADE AT SITE

a. By OWNER / PURCHASER

The plant heat load will be maintained as per steady state conditions explained above within the permissible limits of variation.



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The circulating water flow, HWT and the dissolved solids concentration will be within the permissible range of variations.

The Condenser, Turbine and the Water Treatment System, if applicable will be maintained in clean condition to ensure that thermal parameters stay within the permissible limits of cooling tower testing.

b. By CONTRACTOR

A working platform shall be erected on each hot water riser or a pit provided across the header (buried), as the case may be, to facilitate flow measurement using pitot tube.

Pitot stubs shall be connected to the HW piping (riser or header, as applicable) along with isolation valves to facilitate insertion of pitot tube for flow measurement.

All the necessary measuring instruments, props, scaffolding, necessary manpower, etc. shall be arranged by the Contractor for the purpose of PG testing.

All such instruments and other appurtenances shall be taken back by the Contractor after successful PG testing of the cooling towers.

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embedment. 4.7 <u>NATURAL DRAUGHT COOLING TOWER</u> 4.7.1 Intent of Specification A single Natural Draught Cooling Tower (NDCT) with dedicated cooling water basin, outlet channel, sludge removal sump and valve pit, etc. shall be provided for the 1 x 660 MW unit. This specification covers the requirements of design and construction of natural draught reinforced concrete hyperbolic cooling tower. This section of bidding document deals with the technical specifications for the design and preparation of detailed working drawings and getting them approved by the owner and civil construction works. The provisions of these technical specifications are general in nature and cover broad aspects. Technical specifications outline the minimum requirements. However, it would be the absolute responsibility of the contractor to collect, interpret, analyze all necessary information/data for the successful design and construction of the cooling tower. Structural safety and successful operation of the tower shall be the total responsibility of the contractor notwithstanding the approval of the owner. 4.7.2 Scope of Work The scope of this work shall consist of, but not limited to, the design and construction of reinforced concrete double curvature hyperbolic shell, raker columns, ring beams, foundations including piling work if necessary, cold water basin with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with slide gates and removable screens as specified elsewhere, hoists & monorails, primary and secondary hot water distribution troughs, fill support systems including columns & beams, drift eliminators (if required), testing of cold water basin for water tightness, external stairs, cage ladders, handling facilities at tower top with walkway platform and CW channel, platforms, walkways as specified or required for operation and maintenance, access doors, MS handrails, steel fittings, fixtures, inserts including fabrication, galvanizing and erection of associated steel work and other chemicals on the completed		

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structures etc. all complete as per functional requirements and as per directions of Owner. The scope of work under this specification shall include providing thermal design, structural engineering design and drawings, all labour, supervision, materials, shuttering and scaffolding, construction equipments including tower cranes, hoists, batching plants etc, tools and plant, supply and transportation of all incidental items not shown or specified but reasonably implied for successful completion of the work. The nature of the work shall generally involve foundation/piling, excavation, dewatering, shoring and strutting, backfilling around underground structures and plinth filling, sand filling, disposal of surplus soil outside plant boundary, concreting of grade as specified, formwork including automatic climb form, laser beam instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint filters, drainage and other ancillary items connected with cooling towers as approved. The surface protection that would include all inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channels etc. This list is indicative and the scope shall also include the preparation and supply of all working drawings required for this work. 4.7.3 Cooling Tower Structure 4.7.3.1 The minimum clear distance between the two NDCT's shall be 0.5 times the base diameters as per BS 4485 (not applicable). 4.7.3.2 The cooling tower shell shall be hyperbolic paraboloid. The shell of the cooling tower shall be supported by a set of diagonal columns, which shall be supported by piles and a peripheral pile cap or open foundation as the case may be. 4.7.3.3 Hot water inlet shall be through a pair of MS pipes separately for each compartment of basin, suitably protected. The pipes shall have butterfly valves and also required numbers of thermowell with RTD, pressure and flow measuring instruments. Blow-down shall be tapped from the HW piping.		

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4.7.3.4	Separate piping for hot water inlet from ACW circuit into the NDCT shall be provided by the side of hot water inlet piping for CCW circuit. The ACW piping shall also have butterfly valves. Painting and protection of hot water piping shall be done as per relevant IS codes.	
4.7.3.5	By pass arrangement alongwith isolation valve for approximately 20% of total circulating water flow shall be provided from main Hot water C.W.Pipeline @ G.L to cold water channel including horizontal base plate at bottom of cold water channel.	
4.7.3.6	By pass arrangement alongwith isolation valve for 50% water flow from ACW pipe line to cold water basin shall be provided for each compartment of cold water basin.	
4.7.3.7	To control the hydraulic forces at the change of alignment of the hot water (HW) inlet pipe, a RCC thrust block shall be provided at ground level near the cooling tower along with suitable other supports for pipes above ground level including structural steel works.	
4.7.3.8	The hot water distribution shall be by RCC main and secondary ducts which carry the lateral distribution pipes fitted with nozzles for uniform distribution through the fill.	
4.7.3.9	The concrete main distribution ducts shall be accessible and are to be provided with non-corroding, pressure-sealed inspection openings. Cleaning and sludge-removal openings are to be included on each run at the end of the duct in the main distributor.	
4.7.3.10	The HW distribution arrangement shall be supported independent of the shell by internal columns supported on the floor of the cold water basin. The hot water main and secondary distribution ducts shall be designed for minimum 120% of design flow indicated in the specification with at least 150 mm free board.	
4.7.3.11	The profile of the drift eliminators is to be selected to ensure a maximum degree of precipitation and a minimum of air pressure loss.	
4.7.3.12	Access to the hot water distribution platform and further access to the shell top should be provided with two Galvanized Steel cage ladders.	

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4.7.3.13 The material used for access facilities including steel components for steps, ladders, platforms, catwalks, railings, doors, base frames, mountings, etc must be galvanized and resistant to corrosion. 4.7.3.14 All bolted connections and attachments to concrete must be made out of suitable stainless steel material. 4.7.4 The basin shall be designed with a free board of at least 0.3 m above maximum water level. The cooling tower basin shall be divided into two equal parts by watertight RCC partition for the cleaning and maintenance of one half while the other half is in service. Arrangements for water drainage shall also be provided. Suitable overflow arrangement (Vent of minimum width 600 mm), to maintain the maximum water level at 300 mm below the sill in both the compartments, shall be provided. Minimum 500 mm dead storage shall be considered above invert level of the basin i.e. minimum water level in the basin shall be at least 500 mm above invert level of basin bottom slab. The basin holding capacity shall be minimum 16 minutes between maximum & minimum water level. The bottom of the basin shall be provided with minimum slope of 1:500 towards periphery. The basin shall be provided with the peripheral drain of width 0.50 m with 1:400 slope towards drain sump. The size of drain sump shall not be less than 1.0 m x 1.0 m with required depth. 4.7.5 The cold water from the basin shall be taken out through an opening connected to the main CW closed Channel/duct, which in turn leads to a fore-bay of the CW sump. The cold water from the basin shall flow by gravity to open approach channel leading to the fore-bay. The cold water channel shall be provided with a slide gate. Suitable handling arrangements with a monorail and a chain-operated hoist with a travelling trolley shall be provided for handling of the slide gate. In front of the outlet structure, provision shall be made for de-sludging facilities so that sediments can be withdrawn from the basin. In order to clean the cooling tower basin, sludge drain are to be provided along its perimeter with suitable sludge sump of minimum size 1.0 M x 1.0 M, from where the sludge will be taken out to sludge box/chamber outside the basin for pumping out. The size of Box		

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chamber out side shall not be less than 4.5 m x 2.0 m and shall be provided with suitable sump pits for sludge pumps. The chamber shall be provided with man hole cover not less than size 0.50 m x 0.90 m. Two number sluice gates of suitable size for 300 mm dia opening shall also be provided in the chamber to control the draining from the basin with hand wheel to be operated from the top. Two submersible sludge pumps shall be provided for the removal of sludge from the NDCT to ETP drain. All the drains shall be terminated in the ETP. Out side drain chamber bottom level shall be at least 1.00 m below the bottom level of the inside drain sump bottom level. The necessary drainage opening of at least 300 mm dia shall be provided on both the sides of partition wall. The bottom of the basin shall be provided with at least 1.0 m depression for the area not less than 15.0 m x15.0 m on each side of partition wall of the basin before the basin opening leading to cold water channel. Paving of minimum 2.0 m width with 150 mm thick RCC slab of M20 grade all around the cooling tower with gutter leading to drain chamber shall be provided. 4.7.6 Fill Supporting Arrangement The supporting of the fill is to be achieved by a series of RCC columns arranged in suitable grid spacing and RCC beams in orthogonal directions. Loads from fills, hot water ducts, pipes including water load, wall blocks, etc. shall be considered for column-beam design. To take care of horizontal loads due to seismic and thrust from hot water header, a suitable system of vertical bracings is to be designed and provided in either direction. 4.7.7 Concrete, which is impermeable to water, is to be used for all components, including reinforced concrete components. The composition of the concrete and the cement are to be chosen depending on the chemical analysis of the cooling tower water/cooling tower make-up water.		

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4.7.8 Aviation Obstruction Lights In accordance with ICAO regulations, aviation warning lights are to be installed on top of NDCT along its perimeter. Operating and reserve aviation warning lights are to be positioned next to each other. They are to be connected to completely separate power circuits and to be monitored by relays. Suitable photo-electric sensors, alarm and annunciation systems, etc. shall also be provided along with the required auxiliaries for completing the system in all respects. 4.7.9 Earthing and Lightning Protection A suitable system of earthing and lightning protection, including required hook-up with the plant grid/system, etc. shall be provided completely. All the electrical requirements, including cables shall be as per plant electrical specifications/ Drawings. 4.7.10 Guaranteed Particulars The contractor shall guarantee the following parameters: 4.7.10.1 Cold water temperature At the design point of the cooling tower, the cold water temperature guaranteed by the Contractor in accordance with the performance curve (cooling tower characteristic curve) shall be achieved. The fundamental parameter for the design value of the cold water temperature during acceptance measurement shall be that measured at the cooling tower basin outlet. 4.7.10.2 Drift losses At the design point, the total water mass flow entrained in the air shall not exceed 0.01% of the mass of water circulating. In case the drift eliminator packing is to be used for achieving the specified drift loss then, the same shall be provided by the bidder. If drift eliminators are provided then the drift shall be measured at the top of the drift eliminators.		

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4.7.11 Material resistance All materials (including building materials) are to be chosen and geared to each other such that no damage will be occurred as a result of operational exposure to cooling water. 4.7.12 Latest versions of the following codes and standards shall be used for conducting the performance tests: (a) DIN 1947 – VDI : Acceptance test code for water cooling towers (b) BS: 4485 : Specification for Water Cooling towers (c) BS: 1042 : Methods for the measurement of fluid flow in pipes (d) BS: 3435 : Measurement of electrical power and energy in acceptance testing (e) ASME – 19.5 : Supplements on Instruments and Apparatus 4.7.13 Contractor shall arrange for all the test instrumentation required for conducting the performance guarantee tests. All instruments used for testing shall be calibrated before the tests as per the relevant codes. Should the acceptance tests not produce the guaranteed values, the Contractor shall be granted the right to make improvements. The repeated acceptance measurements shall then be carried out at the Contractor's expense. 4.7.14 Materials All materials including cement, reinforcement steel & structural steel required under this bid shall be provided by the bidder. No materials shall be issued by the Owner.		

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4.7.15 Materials of Construction <table border="0"> <tr><td>(a)</td><td>Cooling tower basin</td><td>: RCC</td></tr> <tr><td>(b)</td><td>Cooling tower shell</td><td>: RCC</td></tr> <tr><td>(c)</td><td>Internal supporting structure, stair cases, etc.</td><td>: RCC</td></tr> <tr><td>(d)</td><td>Louvers / Baffles</td><td>: RCC</td></tr> <tr><td>(e)</td><td>Film Fill</td><td>: PVC</td></tr> <tr><td>(f)</td><td>Fill supports</td><td>: RCC</td></tr> <tr><td>(g)</td><td>Nozzles</td><td>: Polypropylene</td></tr> <tr><td>(h)</td><td>Drift eliminators, if any</td><td>: PVC</td></tr> <tr><td>(i)</td><td>Hot water inlet pipes</td><td>: Mild Steel to IS 2062</td></tr> <tr><td>(j)</td><td>Hot water distribution system</td><td>: AC/PVC</td></tr> <tr><td>(k)</td><td>Distribution trough</td><td>: RCC</td></tr> <tr><td>(l)</td><td>Sluice gates</td><td>: MS Galvanized</td></tr> <tr><td>(m)</td><td>Side guides and mountings</td><td>: SS 316</td></tr> <tr><td>(n)</td><td>Miscellaneous steel structures</td><td>: MS Galvanized</td></tr> <tr><td>(o)</td><td>Screens</td><td>: SS-304</td></tr> </table> 4.7.16 General Requirements All Foundations shall be designed in accordance with provisions of relevant parts of the latest revisions of Indian Standards and according to geotechnical investigation report, approved by Owner. However for soil characteristics and parameters to be adopted in final design, the contractor is requested to do detail geotechnical investigation work as a part of the contract to verify/generate data so required.			(a)	Cooling tower basin	: RCC	(b)	Cooling tower shell	: RCC	(c)	Internal supporting structure, stair cases, etc.	: RCC	(d)	Louvers / Baffles	: RCC	(e)	Film Fill	: PVC	(f)	Fill supports	: RCC	(g)	Nozzles	: Polypropylene	(h)	Drift eliminators, if any	: PVC	(i)	Hot water inlet pipes	: Mild Steel to IS 2062	(j)	Hot water distribution system	: AC/PVC	(k)	Distribution trough	: RCC	(l)	Sluice gates	: MS Galvanized	(m)	Side guides and mountings	: SS 316	(n)	Miscellaneous steel structures	: MS Galvanized	(o)	Screens	: SS-304
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4.7.17 It should be noted that nothing extra whatsoever on account of variation between soil data provided by MSPGCL & that found by detailed geotechnical investigation to be carried out by bidder shall be payable. General Design Criteria 4.7.17.1 Design data: <table><tr><td>(a)</td><td>Quantity</td><td>:</td><td>One (1)</td></tr><tr><td>(b)</td><td>Type of tower</td><td>:</td><td>Counter flow with PVC film fill</td></tr><tr><td>(c)</td><td>Design inlet wet bulb Temperature</td><td>:</td><td>27°C</td></tr><tr><td>(d)</td><td>Relative humidity</td><td>:</td><td>40%</td></tr></table> 4.7.17.2 Design Consideration The cooling tower shall be designed for continuous operation. The hot water distribution system shall be designed to ensure equal distribution of heat load and flow all over the fill area. Wood/timber material shall not be used in any part of the cooling tower. 4.7.17.3 Loading The following loads shall be considered for the design of cooling towers: <table><tr><td>(a)</td><td>Dead loads</td></tr><tr><td>(b)</td><td>Wind loads</td></tr><tr><td>(c)</td><td>Earthquake forces</td></tr><tr><td>(d)</td><td>Loads due to temperature and shrinkage effects. Temperature effects due to solar radiation shall also be considered.</td></tr></table>			(a)	Quantity	:	One (1)	(b)	Type of tower	:	Counter flow with PVC film fill	(c)	Design inlet wet bulb Temperature	:	27°C	(d)	Relative humidity	:	40%	(a)	Dead loads	(b)	Wind loads	(c)	Earthquake forces	(d)	Loads due to temperature and shrinkage effects. Temperature effects due to solar radiation shall also be considered.
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(e) Construction load (f) Foundation settlement etc. (g) Any other load likely to come on cooling tower. 4.7.17.4 Dead Load For assessing the self weight of the structure, the specific weight of the concrete shall be taken as 2500 kg/m³. All other dead loads shall be assessed in accordance with relevant codal provision. Dead load shall include the self weight of structure, weight of fill material, weight due to plugging/chocking of fills, weight of falling water, weight of hot water pipe, weight of water in hot water channel and distribution system including the self weight of channel and distribution system, weight of drift eliminators etc. Secondary stresses, if any, due to permanent fixtures on the shell shall also be considered. In addition, live load on the supporting structure due to maintenance activities related to fills/ducts/distribution system shall be considered. 4.7.17.5 Wind Pressure The wind pressure on the towers shall be assessed on theoretical basis as well as with the help of AERO elastic Model tests in a wind tunnel of turbulent boundary layer as per stipulations of BS 4485:1996 (Part 4). All the theoretical methods outlined hereunder for estimating wind load on cooling tower shell shall be valid only if the towers spaced at clear distance of greater than 0.5 times the base diameter at the finished graded ground level. The theoretical method outlined herein forms the basis only for assessing lowest limit of wind forces and shell structure interaction. For conducting model tests, bidders should survey the whole terrain and make their own assessment of likely critical wind forces & wind structure interaction. It would be the responsibility of the bidder to collect necessary meteorological data duly vetted from the recognized govt. agencies/institutions. After collection of necessary meteorological data, most critical wind speed, wind pressure distribution and other necessary parameter shall		

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be determined by the bidder and get the same vetted by the above agency/ appropriate agency(s). Then with the help of physical model tests in a wind tunnel, offering appropriate aerodynamic similitude, the bidder shall obtain the most critical forces, stresses etc. with cooling tower at various levels and locations. Such model test shall also include all adjacent topographical features, buildings and other structures which are likely to influence the wind load pattern on the tower significantly. The model test shall be carried out in a well reputed institute/testing laboratory after obtaining prior approval from the Owner. The testing agency selected by the bidder shall have requisite experience and should have successfully carried out tests in the past for at least one cooling tower of similar capacity. The model tests shall be duly witnessed and approved by the Owner/consultant. The model test results shall be made available before final approval of the design.

The complete cooling tower shall be designed for all possible wind directions and on the basis of worst load conditions as obtained from Model test and theoretical methods. Under the theoretical method, the circumferential net wind pressure distribution and wind pressure coefficient (p_1) for the tower shell (without meridional ribs) shall be obtained from the "Criteria for structural design of Reinforced concrete Natural Draught Cooling Towers IS: 11504-1985.

The above circumferential wind pressure coefficient (p_1) shall be increased by multiplying it by 1.43 to account for turbulence in the incident wind and load intensification due to turbulence induced by the adjacent cooling tower or the other structures of significant dimensions. Therefore, the actual design circumferential net wind pressure coefficient (p) shall be computed as $p=1.43(p_1)$, where (p_1) is the wind pressure coefficient as per IS: 11504-1985. Enhancement factor 1.43 is considered to take the interference effect of adjacent structures of significant dimensions into account. 10% increment shall be considered for imperfection in construction as per IS: 11504. This factor shall be increased further by 10% during foundation design in absence of model test results. If the model is for C/L of shell, wind load shall be appropriately augmented to cater the increase in diameter of the shell (O.D.).

This design net pressure coefficient (p) and the distribution along the circumference of tower shall be used at all heights of the tower. The above design net pressure coefficient (p) shall include the effect of internal suction.

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In order to compute the quasi-static design wind pressure at a given height along the circumference of the tower, the net design pressure coefficient (p) shall be multiplied by the wind pressure acting at that height [P(z)]. For details, reference shall be made to “Criteria for Wind Resistant Design of Structures and Equipments” and as given below.

The wind pressure at a given height [P(z)] shall be computed as per the stipulations of IS: 875 (Part 3)-1987. For computing the design wind pressure at a given height, the basic wind speed (Vb) shall be taken as Vb=39 m/sec at 10.0 meters height above mean ground level. For computing design wind speed (Vz) at a height z, the risk co-efficient K1=1.06 shall be considered. For coefficient K2, Terrain category 2 as per table 2 of IS: 875 (Part-3) – 1987 shall be considered. Coefficient K3 shall be determined by taking into account nearby plant site and other features of the station & topography. The wind direction for design purposes shall be the one which would induce the worst load conditions. However, coefficient K3 shall not be less than one under any circumstances. The wind pressure at a given height shall be computed theoretically in accordance to the IS Codal position given as under :

$$P_z = 0.6 V_z^2 \text{ N/m}^2$$

The bidder shall also compute the wind pressure (Pz) along the wind direction by Gust Factor (GF) or Gust effective factor method (GEF). Method for estimating the wind load on the tower and other elements, shall be based on IS: 875 (Part-3)-1987. While calculating the gust factor, the term “b” shall be taken as the diameter of the throat in Fig. 10 of IS: 875 (Part-3)-1987.

Design of the tower shall satisfy quasi-static method & GEF method. Dynamic effects on the tower due to wind action shall also be investigated to ascertain the wind induced oscillation such as ovaling and excitation along and across the wind direction. Bidder shall carry out detailed analysis for the tower and consider the worst combination of static & dynamic effects.

In case the bidder proposes to adopt aerodynamic rough surface such as provision of meridional ribs in the cooling tower shell, the pressure coefficients as given in the VGB-BTR KUHLTUMRE GERMAN SPECIFICATIONS (latest) (structural design of cooling towers) shall be permitted. The provisions of BTR may be adopted for choosing the value of circumferential wind pressure coefficient (p1) only. The wind pressure coefficient (p1), as obtained from BTR after accounting for internal suction

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shall be multiplied by a factor 1.43 to arrive at the net design pressure coefficient (p). The bidder shall furnish authorized English Translation of VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (latest) for the review of the Owner. All other stipulations as specified in these specifications shall be met with.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented.

4.7.17.6 Earthquake Forces

The seismic analysis shall be carried out in accordance with IS:1893 (all latest parts) by modal analysis for the hyperbolic cooling towers or any other method as approved by the Owner. The earthquake analysis of the shell and its support columns including the foundations shall be carried out by response spectrum method. For the fill supporting structures (RCC frames) response spectrum method is permitted. The modulus of elasticity for concrete shall be obtained from IS: 456-2000 Clause 6.2.3.1 with an Age Factor of 1.0. All the analysis shall be carried out as per the theory of elasticity. Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant reference where the same has been successfully implemented.

4.7.17.7 Loads due to temperature effects

Stresses due to temperature effects:

The cooling tower shell shall be designed for stress due to axi-symmetric temperature distribution corresponding to external ambient temperature variation from 12°C to 50°C. However, the detailed analysis of actual thermal gradient by considering temperatures inside the tower and external ambient temperatures shall be carried out furnishing detailed references and justification for the same.

The shell shall also be checked for thermal stresses arising due to partial operation of the tower in case the operational philosophy so demands. The analysis for the stresses resulting from non-axi-symmetric temperature loading shall be carried out. In such non-symmetric temperature loading, the

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calculation shall be based upon the operating specification. Besides, the shell shall also be designed for one sided solar radiation effect. Nevertheless an effective temperature difference of at least 25°C across the shell thickness constant over the height and follow a sine functions along half the circumference shall be considered.

Entire analysis and designs adopted shall be fully supported with authenticated literatures/documents along with relevant references where the same has been successfully implemented.

4.7.17.8 Constructional Loadings

The method of construction and the type of formwork to be used shall be decided by the bidder in advance and should be enclosed in the bids submitted. Construction loadings that may occur during execution of work shall be considered in the design of the cooling tower structure. Factors causing temporary loading may include the following depending upon the method of construction.

- (a) Barrowing of concrete
- (b) Scaffolding and formwork
- (c) Loads produced by anchoring devices of climbing scaffolds.
- (d) Hoist fixings
- (e) Storage of materials on scaffolding
- (f) Temporary access
- (g) Tower crane fixings
- (h) Works temporarily omitted for access purposes.

Any other load such as foundation settlement, etc.

All loads likely to act on cooling tower but not specified herein shall also be considered for the design of cooling tower structures.

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In case different degrees of subsoil stiffness exist, effect of the same shall be taken into account. In such a case, for computing settlements, load distributing capacity of the shell may be considered. Differential settlement between adjacent sections of foundation shall be considered under most unfavourable load combination. 4.7.18 Load Combinations Following minimum load combinations shall be considered for the design of cooling towers structures. (a) DL + WL + SL (b) DL + Se L (c) DL + TL (d) DL + WL + TL + SL (e) DL + Se L + TL + SL (f) 1.0 DL + 1.5 WL (g) 0.9 DL + 1.5 WL (h) 0.9 DL - 1.5 WL Where DL = Dead Load WL = Wind Load SL = Settlement Load Se L = Seismic Load TL = Thermal Load		

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In addition to above, construction loads shall be duly accounted for. Under TL various types of thermal loads, as described above, shall be considered separately. Besides above load combination, other load combinations as per relevant IS codes shall also be followed. 4.7.19 Permissible Stresses For load combination (a) to (e), the stresses in concrete and reinforcement shall be designed as per working stress method of IS: 456 with maximum crack width limited to 0.3mm. For the load case (f) to (h), the shell of cooling towers shall be checked by limit state method as per IS: 456. The stress in the reinforcement steel shall not exceed 87% of the specific characteristic strength of reinforcement steel and the compressive stress in the concrete shall not exceed 45% of the specified 28 days cube strength of the concrete as per IS: 456. In the design of the cooling tower shell, column, pile caps, pedestals, ring beams etc, no increase in the strength with the age of the concrete shall be permitted. Permissible stress for steel structures shall be as per IS: 800 (latest) based on working stresses. 4.7.19.1 The cooling tower is more a wind predominant structure, increase in permissible stresses in structure under working stress design & increase in safe bearing capacity for design of foundation under wind load combination shall not be permitted. 4.7.20 Tower Design Consideration 4.7.20.1 General The complete cooling tower, including the shell, columns, ring beam and foundation, shall be structurally analyzed using a proven finite element modeling technique or an approved alternative method including validation of software used for analysis. For elastic analysis, concrete may be assumed to be uncracked, homogenous and isotropic. The design geometric profile,		

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thickness variation and support conditions of shell shall be considered in the structural analysis. Regardless of analysis method adopted, the equilibrium checks of internal forces and external loads shall be performed. Analysis based on a recognized bending theory of the elastic shells shall be adopted for the design of the tower and supporting structures. Geometric imperfections, if exceed the permissible limit, then the analysis of shell shall take into account of such imperfections and resubmitted for Owner"s approval. Boundary conditions shall be realistic and based on actual configuration. The magnitude of the calculated displacements should be within limits of the applied theory. A detailed dynamic analysis shall be carried out for complete tower for seismic forces by response spectrum method. Cooling tower shall also be designed for cross wind oscillations (wind induced vibration) if the fundamental natural frequency of the tower is less than or equal to 1 Hz. Frequency calculation for free vibration analysis shall also be furnished by bidder during detailed engineering. 4.7.20.2 Size and Shape The base diameter, air intake opening height, tower height and throat diameter shall be determined by thermal design consideration by the bidder and submitted to Owner for approval. As the range of possible hyperbolic shell shapes is infinite, the same shall generally conform to the following major proportions, which have been extensively adopted in cooling tower constructions. $H/D = 1.2 \text{ to } 1.55$ Where H is the total tower height above basin sill level. $H_b/H = 0.75 \text{ to } 0.85$		

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Hb is the vertical distance from the throat to basin sill level and 'D' is the base diameter at basin sill level. However, other proven profiles may be permitted subject to approval from the Owner. Bidders shall submit along with the offer complete details of the profile, in case the profile is not within the limits stated above, and the names of the sites where such shell profiles have been successfully constructed. Notwithstanding what is stated above, the Owner reserves the right to accept /reject the shell profile. 4.7.20.3 Tower Shell Boundary Conditions (A) Shell Analysis and Design The following boundary conditions shall be assumed for the design of cooling tower shell: (a) At Upper Edge The top edge of the shell shall be gradually thickened to form a ring beam to guard against possible instability of the top of the shell due to high velocity wind gusts. Top edge shall be considered as a free edge in the analysis. (b) At Lower Edge The lower edge of the shell shall be thickened to form a lower ring beam. The thickness transition from shell to lower ring beam shall be smooth and shall be considered as an integral part of the shell. The lower boundary of the shell shall be considered as elastically supported by discrete columns. The influence of both support structure flexibility and foundation settlement shall be considered in the analysis and design of cooling tower shell. The shell analysis should include following information at 10° plan angle and of not more than 0.05 of the shell height.		

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(i) Meridional and circumferential direct stress resultants and the tangential shear stress resultants. (ii) Meridional and circumferential bending moments. (iii) Displacements normal to the shell mid-surface. (B) Buckling of Tower Shells Critical dynamic pressure (wind pressure) at buckling shall be calculated from BS: 4485 Part-4:1996. Buckling of Cooling Tower shell shall be checked as per Finite Element Analysis using software such as NISA 2, Ansys etc. The factor of safety for snap through buckling shall be more than 5. This requires non linear analysis including simulation of opening in the model. Alternatively bifurcation buckling factor can be calculated using linear Eigen value analysis with modulus of elasticity $E=0.8E_c$, to account for cracked section, with factor of safety more than 7. Besides above, a buckling analysis with wind forces should be made using the theoretical tower geometry and boundary conditions, including the influence of dead weight, by the method of buckling stress state (BSS) approach in accordance with the provisions of VGB/ BS 4485. The buckling safety factor shall be at least 5.0 for load combinations of dead load + wind load. When imperfections in the shell geometry are larger than specified tolerances, the analysis should be rechecked to account for such imperfections and ensure that the desired buckling capacity remains. (C) Opening in Shells Opening through the shells should be avoided as far as possible. They should be of smallest required dimensions and shall be shaped such that stress concentration is minimized at the boundary of the opening.		

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Should thickening of the edges be necessary, it shall be smoothly tapered back to the shell thickness. Openings shall be provided with additional edge reinforcement of a minimum cross sectional area at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition, diagonal reinforcement shall be provided at each corner as close as possible. The total cross-sectional area in cm² of this reinforcement shall be 0.5d, at each corner where d is the shell thickness in cm. No horizontal thrust due to the inlet piping shall be transmitted to the shell. (D) Minimum Thickness of Shell The minimum thickness of the shell excluding ribs shall not be less than 300 mm. (E) Minimum Reinforcement in Shell Spacing and Placement The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415/500 conforming to IS: 1786 – latest. All reinforcement steel shall be corrosion resistant steel/HCRM. The minimum reinforcement to be provided shall be as follows: Top one third portion of shell: 0.4% of concrete cross sectional area along circumferential direction and 0.35% of concrete cross sectional area along meridional direction. Remaining two-third portion: 0.35% of concrete cross sectional area of shell in both meridional and circumferential directions. Minimum bar diameter shall be 10 mm in transverse direction and 12 mm in meridional direction. Spacing of reinforcing bars should not exceed 200 mm in circumferential direction and 250 mm in meridional direction.		

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The two layers of reinforcing meshes shall be adequately joined by S-hook over the total shell surface. At least two S-hooks in each square metre area of shell surface shall be provided. The hooks shall be of minimum 8 mm diameter bars. The concrete cover shall be 50 mm minimum. The relevant provisions of IS: 2210 – Criteria for the design of reinforced concrete shell structures and folded plates and IS: 2204 – Code of Practice for construction of reinforced concrete shell roof shall also be deemed to be applicable. All other design criteria for the cooling tower shell which are not specified above shall be in accordance with BS: 4485 Part 4 and BTR. (F) Provision of meridional ribs in Cooling Tower Shell Meridional ribs in the cooling tower shell may be provided subject to the following conditions: (a) Minimum thickness of shell excluding ribs shall not be less than 300 mm. (b) Co-efficients for pressure distribution around the cooling tower circumference including suction may be taken as per VGB-BTR KUCHLTURMEN SPECIFICATIONS (latest). All other factors including load intensification factors shall be as specified else where in these specifications. (c) Shell buckling and strength shall be checked as per clause-III B above without considering the effect of ribs. (d) All other stipulations as specified in these specifications shall be met with. (e) Bidder shall furnish an authorized English translation of the VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (Latest) during detailed engineering stage.		

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4.7.20.4 Raker Columns Inclination of the column shall closely match the meridional slope at the shell so that the load transfer to foundation takes place through predominantly axial force in columns. Raker columns shall be designed for the most critical forces transferred to an individual rake column from superstructure considering various load combinations as specified in this document. For selecting effective length of the raker columns, following restraints shall be considered: (a) In case columns restrained at both the ends, the effective length shall be 0.8 and 0.6 times the length of the column radially and tangentially respectively. (b) In case columns are restrained at one end only, the effective length of columns shall be 0.9 and 0.7 times the length of columns radially and tangentially respectively. (c) The columns shall be designed based on working stress method except for the forces from DL + 1.5 WL which shall be designed as per limit state of strength method of IS: 456. 4.7.20.5 Crack Width Control Under working stress method the maximum crack width of tower shell, lintels, raker columns and fill support structure shall be controlled up to 0.3 mm on basis of formulas as per IS:456 and relevant British codes. Fill support structures and Drift Eliminators shall be designed as per the load combinations specified in this document. Appropriate Live Loads and imposed loads shall also be considered in addition. The design shall confirm to limit state method as per IS: 456. For fill support structure, the design shall be done considering the weight of fills, falling water, plugging/scaling load and the live load due to the maintenance activities. 4.7.20.6 Prestressed Concrete Members: Design construction and workmanship of prestressed concrete, members shall be in accordance with IS: 1343 (Latest revision). Steel wire for		

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prestressing shall conform to IS: 1785 (Part 1) (latest edition) or IS: 6003 (latest edition). Crack width control shall be limited to 0.1 mm.

Particular attention shall be paid to achieve an effective bond of the wires in pretensioned concrete units. For this purpose, indented wire shall be used. Wires shall be corrosion resistant or should have coating system fit for seawater duty condition.

4.7.20.7 Liquid Retaining Structures:-

- (a) The cold water basin including sludge pits, cold water channels, shall be designed as per IS: 456 (latest) with crack width control of 0.1 mm for outer face of the wall and inside face of the wall shall be designed as per IS 3370.

The structures shall be designed for the following conditions:

- (i) Water filled inside up to maximum level and no earth outside.
 - (ii) Earth pressure with surcharge load of 2.5 t/m², as applicable, and with/without ground water table at 1.0 m below finished ground level outside and no water inside.
- (b) The basin and associated structures shall be checked against uplift for basin empty condition. Stability shall be checked during construction stage as well as maintenance stage. The factor of safety shall be as per IS: 3370.
- (c) Loads during construction, erection and maintenance stage shall also be considered.
- (d) Temperature fluctuations from operation shall be obtained from the design data. Hot water temperature inside and cold air temperature outside shall be considered.
- (e) Basin floor slab shall be designed to rest on piles or raft/mat foundation including fill-pack support structures. The stiffness of the subsoil shall be taken into account. The founding level of the raft/mat shall be either on virgin ground level or shall be placed at higher level

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only after scooping out filled up soil up to virgin ground and then filling back with well compacted sand (80% of relative density) up to the founding level of the raft/mat. The bidder shall ascertain the safe bearing capacity of the stratum at the founding level and may adopt the same subject to Owner's approval. (f) Minimum thickness of basin slab shall be 300 mm with minimum reinforcement 0.35% of gross sectional area in both the directions. Reinforcement shall be placed in two layers, top and bottom surface. The effect of provision of flap valves/pressure release valves shall not be considered in the design of CW basin. In the space underneath the basin floor slab a layer of at least 100 mm thick PCC of mix 1:3:6 shall be provided. (g) All reinforcements used shall be corrosion resistant steel/HCRM. 4.7.20.8 Water Distribution System The structural design of the water distribution system shall consider the worst combination of following loads: (a) Self weight, other imposed loads and live load. (b) Hydraulic pressures during normal operations including pressure surges. (c) Hydraulic pressure due to mal-operation of the tower or supply pumps. The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loading in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design. For the structural design, the pressure level to be considered shall not be less than 1.5 times the design pressure. The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature and ambient temperature.		

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The possibility of vibrations being imposed on the distribution system shall be investigated in the design. Seismic loading on the water distribution system shall also be taken into account. The design shall be carried out based on uncracked section as per IS: 3370 under normal operating conditions. Strength check for worst loading including malfunctioning shall be carried out with stress limitations as per IS: 3370. The construction shall be completely water tight without the use of fillets, sealing compounds etc. The method of construction shall be such so as to avoid excessive rise in temperature of concrete due to release of heat of hydration. 4.7.20.9 Platforms, Walkways, Stairways, Staircases, Internal Grillage etc. These shall be designed as per working stress method IS: 456-2000 and IS: 800 (Latest). The crack width in all RCC structures shall be limited to 0.3 mm. A minimum live load of 400 kg/sqm shall be considered for the design of all platforms, walkways, staircases etc. in addition to their own weight. 4.7.20.10 Steel Structures These structures shall be designed, fabricated and erected as per IS: 800 (latest revision) and other relevant Indian Standard codes for structural steel work. All steel structures shall be coated with anti-corrosive system. 4.7.20.11 Slide Gates and Screens Slide Gates and Screens, as per IS: 5620 conforming to IS: 2062 Gr. A shall be designed for worst combination of operating and maintenance condition. All steel components shall be coated with anti-corrosive paint system. However, all guides of slide gates and screens shall be of stainless steel of Grade AISI 304L 4.7.20.12 Foundations The design of the cooling tower foundation structures shall be based on IS: 456 as per working stress method for worst load combination as specified in IS code In case of load combination DL + 1.5 WL, the limit state method as per IS: 456 shall be adopted.		

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Foundation shall be checked for safety against overturning, sliding and uplift. While checking stability of the structures, neglect favorably acting loads from water fill, soil cover beyond the edge of the foundation. Ground water table shall be considered at 1.0 m below Finished Grade Level of that particular area for design of foundations and all underground water retaining structures. The foundation shall be of minimum M-25 grade concrete resting over 100 mm thick PCC 1:3:6 layers. Clear cover of concrete shall not be less than 50 mm. Pile foundation if adopted shall be designed in accordance with IS: 2911 (Part-I / Sec-I, II and III). Generally net tension should be avoided in the foundations/piles for the shell support foundation unless specifically permitted by the Owner. While accounting for over burden of the soil for checking the foundation against up-lift, dead weight of the soil directly above the pile cap or ring raft, as the case may be, shall only be considered, neglecting the weight of soil in the cone of up-lift above the foundation. The foundation structures will be subjected to following loading and extreme load combination case shall be considered for design. (a) Most critical forces transferred from superstructure for the various load combinations. (b) Uplift forces (c) Loading due to foundation settlement (d) Concentrated local loading from column nodes (e) Thermally induced local loading where supply culverts pass through the foundation structures without structural isolation. (f) Surcharge of 2.5 t/sq.m.		

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CW basin surcharge load shall also be considered in addition to the other relevant loads for the design.

4.7.20.13 Fill Support Structures and Other Structures

The self weight of the pack support structures shall be based on the weight of the packing including weight of standing, running and dripping water, other operation and plugging/chocking (debris/scaling) loads, etc. in accordance with manufacturer's data. In addition, a live load of 100 kg/m² shall also be considered for the design of supporting structures.

For other structures like walkways, platforms, etc. a live load of 400 kg/sq.m shall be considered. Hand railings shall be designed for horizontal load of 60 kg/m².

Wind deflector walls and any other structural elements shall be designed for a horizontal wind load of 80 kg/sqm or as per manufacturer's recommendations, whichever is higher. Thermal loading shall be as per manufacturer's recommendations. Earthquake loading shall be considered based on criteria given for cooling tower. Response spectrum analysis shall be considered.

Design of RCC members shall be based on IS: 456:2000 with limiting crack width of 0.3 mm.

The cold water basin slab/raft shall form the common foundation for the pack support structures. The foundation shall be designed for the most critical forces transferred from CW basin & fill supporting structures including loads introduced by constructional equipments and crane deployed for fill supporting structure or shell erection.

4.7.20.14 Requirements for Concrete and Reinforcement

Cement: - 43 Grade ordinary port land cement shall be used unless otherwise specified.

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Structural concrete shall be of design mix complying with the relevant provisions of IS codes or any International Code of Practice as approved by the Owner.

Durability of the concrete shall conform to severe exposure category as per Table 3 of IS: 456 except noted specifically otherwise. Minimum cement content of all RCC structures shall be 360 kg/cum except in case of concrete blended with GGBS specified above & piling.

Reinforcement shall conform to grade Fe 415/500 as per IS: 1786 except noted otherwise. All reinforcements used in RCC structure shall be corrosion resistant. Column reinforcing bars shall be carefully anchored in the shell and foundation. The anchoring length shall not be less than 80 times the diameter of the bars.

All foundations structures shall be provided on all sides with a minimum reinforcement of 0.12% of gross cross-sectional area distributed over top and bottom faces.

The minimum grade of concrete of structural components of cooling towers shall be as follows in accordance with IS: 456.

(a)	Shell and Raker Columns	:	M-40 grade
(b)	Pre-cast pre-stressed elements	:	M-35 grade
(c)	All other RCC concrete	:	M-30 grade
(d)	PCC encasement concrete except piles	:	M-25 grade
(e)	Piles (with OPC/PPC)	:	M 25 grade
(f)	Tower foundation	:	M-25 grade
(g)	Mud mat PCC	:	M-10 grade

Coarse and fine aggregates shall be specially selected to ensure that they are not susceptible to alkali/chloride attack or prone to disintegration at high temperatures. In particular, limestone aggregates shall never be used. The

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maximum size of coarse aggregate shall not be larger than $1/8^{\text{th}}$ narrowest dimension between reinforcement bars not more than 20 mm.

Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means as directed by the Engineer-in-charge.

The water cement ratio by weight shall be 0.45 maximum including free moisture in the aggregates and slump should be suitably decided to provide good quality concrete work.

4.7.20.15 Admixtures

Admixtures may be permitted to be used in accordance with relevant IS codes to modify the rate of hardening or setting, to improve workability or as an aid to control concrete quality. The Owner reserves the right to direct the contractor to conduct laboratory tests or use test data, or other satisfactory reference before granting approval. The cost of all tests conducted shall be borne by the contractor. The admixture shall be used in strict accordance with the manufacturer's directions and/or as directed by the Owner. No extra payment will be made to the contractor on account of using admixtures.

Particular attention must be given to concrete placement because of the thin wall section and the presence of reinforcing steel. Consolidation of concrete shall be by vibration. Removal of air and water at the form surface shall be by vibration and rodding. Particular attention shall be paid to accurately shape the corners at all openings.

Point of discharge of the concrete in to the forms be 1500 mm max. above the concrete surface. Concrete shall be deposited in approximately level layers not greater than 400 mm deep unless permitted otherwise.

Concrete in the cooling tower shell in each lift shall be so laid that the no. of vertical or inclined construction joints are minimized to the extent possible. Horizontal construction joints shall be maintained at uniform spacing throughout the height of the cooling tower as per the directions of the Owner. Special attention shall be paid to proper curing of vertical faces of the cooling tower shell so that these do not remain dry. All thin walled structural members shall be protected by means of curing agents. It is recommended to use a curing agent for the cooling tower shell providing additional protection

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like a single transparent cooling with a material based on vinyl mixed polymer. Inside face of the shell should be protected by a second pigmented coating of the same base material. Any other method of curing, if permitted by the Owner may be used.

Sampling and testing of concrete shall be carried out as stated in Technical Specification elsewhere and as per relevant Indian Standard Codes. However, following minimum tests shall be carried out, irrespective of whatever stated otherwise:

Test of compressive strength

Columns – 1 Set of 3 cubes per column

Shell- 2 sets of 3 cubes per climbing section

4.7.20.16 Cover to Reinforcement

Unless indicated otherwise the clear concrete cover for reinforcement shall be as per IS Codes.

The correct cover shall be maintained by cement mortar spacers/cubes or other approved means, reinforcement for footing/pile caps, grade beam, and slabs on sub-grade shall be supported on pre-cast concrete cover block as approved by Engineer-in-charge. The use of pebbles or stones as cover blocks shall not be permitted.

The 28 days crushing strength of cement mortar cubes/pre-cast concrete cover blocks shall be at least equal to the specified strength of concrete in which the cubes/blocks are embedded.

The minimum clear distance between reinforcing bars shall be in accordance with IS: 456 (latest edition) or as specified elsewhere in this specification.

All lapping of reinforcement bars in the cooling tower shell shall be by lapping as per relevant codal provisions. Prior approval of the Owner shall be taken for deciding the method of lapping the reinforcement bars in the shell.

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Tolerances for the cooling tower construction shall be in accordance with the following: (a) Shell wall centerline in horizontal plane measured radially at mid point on a 3m wide chord is + 15 mm. (b) Shell wall centerline in meridional plane measured over a height of 1m is + 10 mm. (c) Shell thickness is + 10 mm or -5mm. (d) Horizontal radius of shell at any section other than shell base is ± 50 mm. (e) Horizontal radius at shell base is ± 40 mm. 4.7.20.17 Checking of shell geometry Check for absolute positions may be carried out from ground stations arranged at not more than 10 degree plan angle apart. Readings of horizontal radius shall be taken at every 6m height or weekly during construction period whichever is more frequent. If the permissible dimensional tolerance are exceeded the Owner will instruct the contractor, in writing, to stop construction of the shell. The Contractor shall then examine the situation and submit a report to the Owner who may require the contractor to demonstrate by calculations that the structural integrity of the shell will not be impaired as a result of the imperfections. The calculations shall be submitted to the Owner, for approval, before construction will be permitted to proceed. If in the opinion of the Owner the calculations show that the integrity of the shell could be threatened, the Contractor will be required to submit to the Owner detailed arrangement and supporting calculations to set right the shell geometry for approval, before construction will be permitted to proceed. The cost of carrying out the calculation, any remedial work required and idle time or any delays to the construction programme as a result of dimensional tolerances being exceeded will be borne by the contractor.		

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Adjustment to the tower shell line on the basis of the survey results shall be made gradually; limiting the maximum change of direction from the existing vertical shell profile to be not more than an angular change of 10 mm measured over 1m of height. Any such adjustment shall be made with full knowledge and consent of the Owner.

The contractor shall carry out an as-built-survey of each lift of the shell. The results of these checks will be recorded on a suitably developed drawing of the shell from which it will be possible to locate the survey check point. A copy of these results will be presented to the Owner prior to commencing the next shell pour.

The contractor's shell construction procedures shall include for providing the Owner with the facilities and a reasonable time period as may be required to carry out an independent check of the completed works.

Suitable communication system such as telephone, wireless equipments, etc. shall be provided by the contractor so that the communications are possible at different elevations of the tower from the ground during construction.

All piling work shall be carried out by specialist subcontractor approved by the Owner. Initial pile load test shall be carried out for at least 3 sets of piles for direct compression and lateral load.

Since the effective action of the piles will depend on the adopted method of construction, the contractor shall guarantee that the piles, as constructed by the sub-contractor, shall effectively transmit the maximum loads which can be imposed on the foundation soil and corresponding maximum deflections.

4.7.20.18 General Requirements

- (a) The basin slab shall be divided into two equal parts by a partition wall designed to withstand full hydrostatic pressure, with one side empty. The basin construction joints shall be made watertight by injection of chemical grout through nipples. The basin construction shall be tested for water tightness, in accordance with IS: 3370 (Part I) (Latest edition). The cost of the test and any rectification and re-test if required is deemed to be included in the contractor's quoted price. Any cost of

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filling and emptying of the basin and to rectify defects shall also be borne by the contractor. (b) PVC ribbed water stops with central bulb shall be used where expansion joints are envisaged. The minimum thickness of PVC ribbed water stops with central bulb will be 10 mm and minimum width 250 mm. (c) The basin floor of each compartment shall be provided with a slope of not less than 1 in 500 towards sump for dewatering. From sump, the water will be drained by C.I. drain pipe, embedded below the basin floor, into a drain chamber outside the tower basin or as per the arrangements described elsewhere in the tender document. Suitable sluice gates (rising spindle type) conforming to IS: 3042 or sluice valves shall be provided in the drain chamber or any other arrangement specified elsewhere in the tender document. Suitable operating platform with access ladders for operating the gates or valves and pipes, shall be provided in the drain box.. (d) A 250 mm high sill shall separate the pond floor from the tower outlet. (e) Uniform surface on the top of basin floor shall be provided. In case undulated surface is observed, a top of layer of minimum 25 mm thick 1:3 mix mortar to be provided to achieve uniform surface. (f) Fill will be of film type supported on RCC beam. Film fill should be characterized by reduced air pressure losses, and shall not susceptible to clogging. Design and facing of the film fill shall be such as to expose high air/water surface with minimum air pressure drop. The sluice gates shall be of structural steel with anti-corrosive coating specified elsewhere. Number of sluice gates and removable screen shall be two (2) per tower. Proper rubber seal shall be provided so as to avoid any leakage of water. The rubber seal provided for the sluice gates be tested in accordance with the relevant Indian Standard Code. Sluice gates shall be checked for water tightness and smooth operation in dry and wet conditions.		

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Suitable facilities, as approved by the Owner, shall be provided for handling of sluice gates and screens.

A screed or concrete layer not less than 100 mm thick and of grade not weaker than 1:3:6 mix conforming to IS: 456-2000 shall be provided below the cold water basin and other liquid retaining structures.

Lean concrete below other foundations and underground structures, unless noted otherwise shall be 1:3:6 nominal mix (with aggregate of nominal size 40 mm maximum) and shall be at least 100 mm thick.

All exposed surfaces of concrete, i.e. inside surface of tower basin, entire inner surface of shell, fill supporting beams, columns and bracings, raker columns etc. which are in contact with water/moisture shall be given three coats of water proof bituminous paint of approved make.

Unless noted otherwise all concrete surface which are in contact with the earth shall be applied with anticorrosive coat system.

Water proofing and plasticizer admixtures conforming to relevant IS codes may be added as per manufacturer's instruction to the concrete subject to approval of the Owner.

The tower shall be provided with two numbers external RC staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise. The steps shall have a rise of about 125 mm and tread of about 250 mm. Anti-skid nosing at each step shall be provided.

Minimum size of all doors shall be 2100 mm high (clear) and 1200 mm wide (clear). The door shall be of steel with anti-corrosive coating of polyurethane as specified elsewhere. However, FRP material or equivalent may also be used subject to approval of the Owner. The door shall be air tight when closed.

The hand railing on both sides of the staircase shall be galvanized with three rails of 32 mm NB pipes conforming to medium class as per IS:1239, and posts conforming to medium class as per IS:1239 of 32 mm dia galvanized

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pipes spaced not more than 1.2 m centers. The top hand rail shall be at 1000 mm above the steps. Complete hand rails shall be applied with anti-corrosive coating system as specified elsewhere.

All galvanization work shall have 610 gm/sq.m of deposit.

Approved walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. A reinforced concrete platform of 1500 mm clear width shall be provided around the tower valves. Other walkways shall be at least 600 mm wide with 50 mm (minimum) safety kerbs along each edge. Access ways shall be clear of all obstructions such as distribution pipe support beams, drift eliminator support beams etc. The walkways shall be provided with transverse slots or other opening which will permit the free passage of air and water.

Hot double dip galvanized handrails shall be provided on all sides where there is a risk of falling through the fill.

Reinforced concrete platforms 1.2 m clear width all around the tower circumference shall be provided on the tower for fixing of aviation warning light at levels specified elsewhere. Two diametrically opposite galvanized M.S. cage ladder (as per IS: 3696) with Fall protection system on the outside of shell upto full height of cooling tower shall be provided. The fall protection system/vertical fall arrest anchorage system (conforming to EN 353-1:2002) shall be provided as an integrated fall arrest solution made of a vertical Aluminium Alloy Notched Guide Rail over which glides a Guided – Type Fall Arrest Trolley. The trolley shall move up and down accompanying the user who is connected with it with the help of small shock absorbing lanyard. The full body Harness shall be provided.

The trolley shall be made of stainless steel with wheels made of brass to prevent corrosion and to enable smooth working.

The trolley shall immediately lock over the rail, in case of sudden fall with provision of the Uni-directional locking system which does not allow it to free fall down the rail.

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The cage ladder shall have 600 mm. wide, 20 mm dia rungs at 300 mm c/c with stays at every 1800 mm, connected to the concrete shell and galvanized Horizontal M.S. cage ring of 50mm x 6mm thick consisting of 50 mm x 6 mm vertical cage flats on the exterior surface of cooling tower up to top of the tower. In addition to the top platform, intermediate landings of 1.0m x 1.0m with handrails shall be provided at every 8 to 10 m height of the MS ladders throughout. Some of these landing levels shall be suitably adjusted to give access to aviation warning beacons for maintenance. Handrails shall be provided on all platforms. The ladder leading to the top platform shall have approach from ground via the RCC staircase.

In order to provide approach for maintenance of shell, all Landing platforms shall have 70 mm internal diameter puddle flanged C.I. pipes for passing ropes during maintenance of tower shell.

Steel gratings, where required, shall be fabricated out of steel flats with minimum thickness of 6 mm. Thickness of fabricated grating shall be 32 mm with flats so arranged as to have a maximum opening of 25 mm or less. Treads for staircases, where needed, shall be of similar grating construction but provided with toe flats of 6 mm thick, and non-skid nosing in an approved manner extending up to 100 mm above the walkway surface. All steel gratings shall be galvanized and applied with anticorrosive coating as specified elsewhere.

The mild steel parts of structures used in cooling towers shall be hot double dip galvanized unless it is coated with a separate anti-corrosive coating system. The minimum coating shall be 610 gm/sq.m and shall comply with relevant IS codes. Galvanizing shall be checked and tested in accordance with IS: 2629. All welding shall be done before galvanizing. Any site joints required to be carried out after galvanizing shall be either flanged or screwed joints. Nails, nuts, bolts and all components coming in direct contact with water shall be of stainless steel of AISI 304 or equivalent.

The finished ground level shall be paved for 2.0m width all round the outer edge of the cold water basin. The paving shall consist of 150 thick RCC slab of M-20 grade. The minimum reinforcement shall be 10 mm dia spaced 150 mm center to center both ways top and bottom. The RCC slab shall be overlaid 100 mm thick M-10 PCC mat and 300 mm well compacted sand layer. All

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around peripheral RCC drain leading to drain chamber shall be suitably provided. (g) Two (2) Slide gates of suitable opening size conforming to IS: 5620 complete with embedded parts of SS 304L, guide frames of SS 304L, gate conforming to IS: 2062 Gr. A, side seal of EPDM Musical Note, bottom seal of EPDM, all other accessories and hardware necessary to install and operate the system as per specifications and drawings or as directed by Engineer-in-charge, complete in all respects. The slide gates shall generally meet the following requirements: (i) Standard : IS: 5620 (ii) Depth of water column for design : 3 m (iii) Guide frame (Embedded in Concrete) : MSHDG with SS 316 L sealing surface (iv) Gate (including supporting frame) : IS 2062 Gr. A (v) Slide plates of gate : SS-304 L (vi) Slide Seal : EPDM Musical note confirms to IS: 11855 (vii) Bottom Seal : EPDM confirms to IS: 11855 (viii) Painting : Specified elsewhere (ix) Fasteners : SS 304 (h) Two (2) Coarse Screens with guide frame to be suitably installed in the cold water channel and made of 6 SWG wire mesh of SS 304L having 16 mm x 16 mm openings with trash tray and embedded parts of SS 304L, screen frame of CS (galvanized to 610 gm/sq.m), guide frame of SS 304L and all other accessories and hardware necessary to install and operate the system as directed by Engineer-in-charge, complete in all respects.		

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(i) Materials : SS 304 L (ii) Mesh Size : 16 mm x 16 mm square openings with 6 SWG wire (iii) Supporting Frame : MSHDG with SS 304L slide parts (iv) Guide Frame : MSHDG with SS 316 L (Embedded in Concrete) sealing surface (v) Trash Tray : MSHDG (vi) Fasteners : SS 304 (i) Two (2) Fine Screens with guide frame to be suitably installed in the cold water channel and made of 8 SWG wire mesh of SS 304L having 12 mm x 12 mm openings with trash tray and embedded parts of SS 304L, screen frame of CS (galvanized to 610 gm/sq.m), guide frame of SS 304L and all other accessories and hardware necessary to install and operate the system as per specifications and drawings or as directed by Engineer-in-charge, complete in all respects. (i) Materials : SS 304 L (ii) Mesh Size : 12 mm x 12 mm square openings with 8 SWG wire (iii) Supporting Frame : MSHDG with SS 304L slide parts (iv) Guide Frame : MSHDG with SS 316 L (Embedded in Concrete) sealing surface (v) Trash Tray : MSHDG (vi) Fasteners : SS 304		

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(j) Handling facilities of approved make in Cold Water Channel including fabrication, erection complete with all the necessary accessories, embedded parts, hardware, etc. hot double dip galvanized as per IS: 4759 with 610 gm/sq.m of zinc coating as per specifications or as directed by Engineer-in-charge, complete in all respects. (k) Monorails for Slide gates and Screens shall be ISMB 300. Monorail trolleys (manual type) moving over I-beams. Chain pulley block (3.0 Ton capacity with 5 m chain) conforming to IS:3832 with 5m load chain conforming to IS: 3109 complete with necessary accessories such as hooks, slings etc with hardware as per specifications or as directed by Engineer-in-charge, complete in all respects. (l) Handling Facilities on top of cooling tower including fabrication, erection complete with all the necessary accessories, embedded parts, hardware, etc. hot double dip galvanized as per IS: 4759 with 610 gm/sq.m of zinc coating as per specifications or as directed by Engineer-in-charge, complete in all respects for Brackets, hot double dip galvanized as per IS: 4759 with 610 gm/sq.m coating. Swiveling type lifting arm complete with swiveling brackets, pins, etc. along with 250 mm diameter CS pulleys, and all the necessary embedded parts, inserts, hardware, etc. hot double dip galvanized as per IS: 4759 with 610 gm/sq.m coating. (m) 20 mm diameter MS rungs, hot double dip galvanized as per IS: 4759 with 610 gm/sq.m coating and complete with all accessories as per specifications or as directed by Engineer-in-charge. (n) MS structural supports in trusses for HW pipe with all bracings, brackets, cleats, gusset plates, etc. as per detailed drawings or as directed including cutting, fabricating, hoisting, erecting, fixing in position, welded connections and painting with Red Oxide Zinc Chromate primer etc. complete as per specifications or as directed by Engineer-in-charge. (o) MSHDG Access Door with frame in hollow metal construction of 2.1m clear height x 1.2m clear width x 45mm thk with galvanizing to 610 gm/sq.m coating and of 18 Gauge sheet with suitable stiffeners of same material including accessories & fixtures like frame, hinges,		

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latches, hardware etc complete as per specifications or as directed by Engineer-in-charge (p) Minimum two (2) 300 NB flanged CI pipes of Class 'A' type confirming IS: 1536 as directed by Engineer-in-charge shall be provided in the drain sumps for sludge removal. (q) At least two (2) 300 mm dia. Sluice gates conforming to IS: 3042 Class-I as directed by Engineer-in-charge shall be provided for sluice operations. (r) All the MS piping conforming to IS: 3589 and MS plates as per IS: 2062 including bends, T's, elbows, reducers etc. complete with all the necessary HDGS hardware, gaskets etc. including fabrication, cutting, aligning, welding, lowering, laying, hydro-testing etc. shall be provided as per specifications or as directed by Engineer-in-charge for all diameter pipes. (s) Two (2) Double Flanged Butterfly valves of suitable diameter and of approved make conforming to AWWA C-504 / BS: 5155 with mating flanges and complete accessories and hardware as per specifications including aligning, erecting, testing etc. complete in all respects shall be provided separately in the CCW and ACW HW piping respectively. (t) Suitable MSHDG drain nipple with suitable drain plug for flushing of Primary HW ducts and complete with accessories and hardware as per specifications including aligning, erecting, testing etc. all as directed by Engineer-in-charge. (u) Required numbers of 80NB x 200mm long MS heavy duty Stub connections as per IS: 1289 with isolating ball valves as per IS:9890 of threaded type for flow measurement in HW pipes and complete with accessories & hardware as per specifications including aligning, erecting etc. and as directed by Engineer-in-charge. (v) At least four nos. of Dial type pressure gauges of 6" dial size as per IS:3624 including stub connection with isolation ball valve as per IS:9890 and complete accessories, hardware as per specifications		

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including erecting, testing etc necessary for installing & operating the system shall be provide. (w) All the under-ground piping shall be suitably surface prepared and “coated and wrapped” with epoxy and fiberglass 'RP' tissue as per relevant specifications and as directed by the Engineer-in-charge. (x) All the above-ground piping shall also be surface prepared and painted on outside surface as per relevant specifications and as directed with approved make and type of paints, all as directed by Engineer-in-charge. (y) The PVC film fills made from virgin PVC shall be UV stabilized and of approved make in black colour having 17/19 mm cross flutes with 0.25 mm uniform thickness and double edge folding to meet the requirements of CTI code STD-136. It shall have a heat transfer area not less than 148 m²/m³. UV test shall be conducted as per ISO 4892 and impact test as per ASTM-D-256. The required amount of gluing compound to make modules of fills shall also be provided by the bidder. (z) AC pipes of suitable diameters and of class 15 grade as per IS: 1592 with spigot and including drilling of holes for fixing nozzles, hoisting, grouting in RCC ducts, erecting, jointing with required accessories, testing etc. including end caps complete as per specification and as directed for the full functionality of the system shall be provided. (aa) PVC pipes of suitable diameter, 6kg/ cm² rated conforming to IS: 4985 including drilling of holes for fixing nozzles, erecting, jointing with required accessories, testing etc. including end caps complete as per specification and as directed for the full functionality of the system shall be provided. (bb) Required number of Polypropylene Nozzles of suitable opening sizes to cater to varied water flow rate as per specification or as directed by Engineer-in-charge, complete with all the necessary hardware required for fastening the nozzles to the AC pipes including accessories, hardware etc. shall be provided.		

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(cc) Thermal performance Test involving measurement of water flow as per BS:1042 using pitot tube confirming to ISO:3966, air temperatures (WBT & DBT) using mechanically aspirated Psychrometer, water temperatures (HWT & CWT) using mercury in glass thermometers, air flow using anemometer as per specifications and as directed by the Engineer-in-Charge shall be done by the bidder. All the instruments shall be calibrated (at IIT/IISC) within 6 months prior to test. (dd) Minimum eight nos. of high intensity white flashing type aviation obstruction light at each level as per fig no 6.6 of appendix 6 of annexure 14 of ICAO regulations and Director General of civil aviation requirements and with corrosion resistant aluminum casting finished in stove enameled control gear suitable for 200/240V, 50Hz supply, complete as per specification shall be provided. Access should be provided to all aviation warning lights & flashing lights shall be flashed simultaneously. The life of AOLs shall be more than 10 years and with all the necessary fixing accessories as directed by Engineer-in-charge. The AOL system shall be provided with Photoelectric light detectors to monitor north sky for controlling the aviation warning lights. The lights should be switched on when the ambient light goes below 35 candelas and switched off when the intensity is more than 58 candelas. The lights should not be switched off due to momentary increases in light intensities due to lightning flashes or any other short bursts of light. The detectors should be complete with all the accessories, hardware etc. necessary for installation. The facility for Auto/Manual operation shall be provided. AOL distribution board shall be fed from emergency power distribution board. If high intensity lights are not available indigenously then Bidder shall import the same. (ee) All cables shall be heavy duty PVC insulated, GI wire / flat armored, PVC sheathed, 650/1100V grade FRLS copper cable as per IS: 1554 Part-I with owner's approval. The cable shall be clamped at every 750 mm along its run and will include all the hard ware required for its fixing and terminations etc. The Junction/Terminal boxes should be provided wherever required. The cable schedule shall be as under: 4C x 10 sq.mm Copper Cable for aviation warning lights		

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4C x 6 sq.mm Copper cable for power receptacles, stair case lighting and tail end aviation warning lights etc. 2C x 2.5 Sq.mm copper cable for local connection from local Junction box to aviation warning lights. (ff) The bidder shall also provide 240V x 15A single phase 3-pin outdoor, weather proof, industrial type switch- -socket outlets with inter-lock switches and fitted with metal cap. Required nos. of weather & dust proof (IP-55) 200 mm x 150 mm x 100 mm deep junction box (2/3/4 way) made out of 2mm thk G.S. with ELMEX type terminals, glands etc. complete shall also be provided. (gg) A Lighting Distribution Board and Control Panel for Aviation Warning Lights fabricated from 2 mm thk sheet steel, dust and vermin proof and removable gland plates at top and bottom with ELMEX type connectors and with suitable earthing including 2 nos. 32A TPN incomers, HRC fuses and 2 nos. 32A outgoing connections with HRC fuses and Common Flasher shall be provided. Two inputs will be provided by the Owner – one the main supply and the other as stand by. Automatic change over with suitable delay timers with Auto/ Manual operation shall be provided by the bidder. (hh) To care of ICAO and DGCA requirements, the bidder shall provide Temporary Aviation Warning Lights during construction above the 50m level from general ground level. (ii) The earthing and lightning protection system shall be as per IS: 3043 in general. Air terminators made out of 2m long 40 dia MSHDG round bar with pointed top and clamped at minimum 3 points with heavy duty G.I. clamps shall be provided. It shall be ensured that 1.2 m of the air terminator shall be projecting above the top of the cooling tower. (jj) A 50 x 6 thk GI flat Coronal band connecting all air terminator on one side and to the down conductor on the lower side complete with all the necessary fixtures, hardware etc. required for installation shall be provided. The clamps used shall be GI and heavy duty and shall be fixed approx 1m below the top of the cooling tower and clamped at the spacing not more than 1m C/C. Also, a 50 x 6 thk GI flat down		

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conductor complete with all the necessary fixtures, hardware etc. required for installation shall be included. The down conductors on the top shall be connected to the coronal band and on the lower side they shall be connected to the test links. The clamping shall be at 1m C/ C with heavy duty GI clamps. The down conductors shall be in one piece as far as possible. The necessary joints shall be of fully welded type and not bolted type except at the test link. These conductors shall be embedded in the concrete of the shell with a minimum cover of 50mm and shall come out of the concrete at the top and bottom of ring beam. (kk) The Earth conductor to be provided by the bidder shall be made out of 40 mm Dia. MS round bar complete with all the necessary fixtures, hardware etc. required for installation and shall be supplied and installed between test link on one side and to the earth mat on the other side. Earthing electrode of dia. 40 mm MS rod x 3m long and making of earth pit as per IS:3043 complete with all the necessary fixtures, hardware etc. required for installation and connection to the earth mat shall also be in the scope of the bidder. (ll) Temporary lightning protection system during construction to meet ICAO and DGCA requirements shall be provided by the bidder, complete with all the necessary fixtures, hardware etc. required for installation. (mm) The bidder shall conduct tests on circuit as per specification or as directed by Engineer-in-charge. (nn) Required nos. of thermowell complete with all the necessary fixtures, hardware etc. required for installation shall be provided by the bidder and he shall also provide required nos. of Temperature and Pressure Gauges, RTDs, Flow Measuring Devices, etc. complete with all the necessary fixtures, hardware etc. required for installation. (oo) The butterfly valves shall be provided with 2NO+2NC potential free limit switches for BF valves complete with all the necessary fixtures, hardware etc. required for installation.		

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(pp) (i) Butterfly valve specification (REFER VOLUME III-F,SECTION 3) All the butterfly valves shall be complete with graduated position indicator, arrow indicating the flow direction. The valves shall be suitable for erection in any position (Horizontal/Vertical, etc.). The operating mechanism shall be mounted directly on or supported from valve body. All the butterfly valves shall be provided with hand wheel. Butterfly valves of size 350 NB and above shall be provided with reduction gear units. Valves shall close in clockwise direction. The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions. The hand controls shall be provided with locking systems to avoid the disk assuming a not desired position during operation. The pulling force required on the hand wheel-rim shall not exceed 30 Kg. when operating the valve under full flow and operating pressure. The reduction units shall be watertight, complete with lubrication and position indicator. Only one type of valve shall be provided, either cast or fabricated type. Mixing of two types of valves is not considered acceptable. (ii) Ball valve specification (REFER VOLUME III-F, SECTION 2) (qq) Flanges For valves designed as per AWWA C-504, valve flanges shall conform to ANSI B16.1 Class 125 for CI valves and AWWA C-207 Class D for fabricated steel valves. The counter flanges shall conform to AWWA C-207 Class D. For valves designed as per BS: 5155 the flanges shall be as per BS: 4504. All the flanges shall be of slip-on and flat-face type. Flanges shall be fabricated from steel plates conforming to IS: 2062. 4.7.21 The bidder has to furnish the thermal design calculations in the form of design basis with necessary calculations, curves, references etc. of the cooling tower for approval of the owner/consultant. The bidder has to provide NDCT as per the actual thermal design calculations.		

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4.7.22 Performance Guarantee

Performance/Acceptance test shall be carried out for determination of the thermal capability and verification of the guarantee of the cooling tower constructed at the project.

- (a) Test shall be conducted by accredited representatives of the contractor and owner. The contractor shall be given permission to inspect the tower in advance. Contractor's representatives shall witness all phases of the test and record the data jointly with Owner's representative.
- (b) The responsibility for conducting the test shall be with the contractor.
- (c) All test instruments required for the Performance test shall be provided by the contractor. The calibration of the test instruments shall be the responsibility of the contractor.
- (d) Calibration of the test instruments shall be carried out by an approved independent agency. The calibration of the equipment should not be older than six months before the test and should be valid at the time of testing.
- (e) The performance of cooling tower shall be compared with the performance required on the basis of the Performance curves for 80%, 90%, 100% and 120% of design water flow.
- (f) The performance test shall be generally as per CTI Code ATC-105 / BS: 4485 Part-II using characteristic curve method.
- (g) Every effort shall be made to conduct the test when the conditions are very close to the design condition. The station power load will be maintained near at its maximum.
- (h) The performance test shall be taken two times viz. at the end of May when the atmospheric temperature is maximum & in the month of July/August when it is wettest. However, no credit will be given for any uncalled improvements in the guarantee performance and to this extent contractor will not be eligible to receive any payment for interpretation of the performance clause in opposite direction.

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In case the contractor refuses to carry out any modifications in spite of the initial performance test having shown definitely incorrect results, it shall be rightful for owner to take over the entire cooling tower along with all plants and tools made available by him at site of work and modify the cooling tower in accordance with that of Owner' s own notions about adjustments/ redesign as required and in that case contractor will have no claim on the Owner. It shall also be rightful for the Owner to appoint at contractor's risk and cost any separate consulting and/or contracting agency in respect of such adjustments/modifications. Contractor will be considered not to have acted in positive manner in respect of the failure to give the goods during the initial performance test in the event of contractors not having taken definite action within a period of one month of such initial performance test. (i) ACCEPTANCE CRITERIA shall be in terms of percentage capability of cooling tower as per PG test report. 4.7.23 Layout and Levels The layout fixing the location and levels of all structures shall be made w.r.t. plant's grids and bench marks given by the Owner. 4.7.24 Approval of Design and Drawings The bidder shall submit detailed thermal design basis and calculations in the form of a report to meet BS: 4485 requirements. The Owner/Consultant shall check and approve the thermal design. Once the thermal design is approved, the bidder shall submit detailed analysis & design calculations with 3 hard copies of each of the drawings for the cooling tower structures including design assumptions along with general arrangement drawings for the approval of the Owner/Consultant. The theoretical background utilized for developing the computer programmes shall be made available to the Owner. This shall be given by the bidder before approval of designs. One set of analysis & design calculation/drawings duly approved/marked with comments by the Owner shall be returned to the bidder. After receipt of approval from the Owner, the bidder shall submit copies of final detailed construction/fabrication drawings as per Distribution Schedule for the approval of the Owners. One set of drawings shall be returned duly		

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approved which will become the basis for taking up construction. The bidder shall also furnish to the Owner one good quality permanent negative (film type) of each of the final approved drawings. Additionally, all drawings shall be prepared in AUTOCAD and CD's shall be submitted to the Owner for record. The approval of the Owner shall not relieve the bidder from the responsibility of adequacy of the design and correctness of the drawing.		
4.7.25	Vendor List for NDCT	
	For vendor list of NDCT REFER MASTER SPECIFICATION VOLUME –II SECTION 11.	
4.8	<u>RAW WATER SYSTEM AND OTHER PUMP HOUSES :</u> <u>RAW WATER & FIREWATER PUMP HOUSE</u>	
4.8.1	Pump House shall be provided for housing raw water/fire water pump. Separate bays shall be provided for each pump by providing intermediate dividing RCC piers between the pumps.	
4.8.1.1	(a) All pump houses shall be provided with minimum two sets of stop logs for the respective pump bay dimensions along with electrically operated hoisting arrangements. Steel embedments required for stop logs shall be provided for all bays. (b) All bays of pump houses shall be provided with a removable trash rack including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack of respective pump bay dimension shall also be supplied for each pump house. (c) Stop logs, trash racks and hoists shall be supplied in accordance with the specifications given elsewhere. (d) The fire water pumps shall have positive suction. The raw water and fire water pumps shall draw water from the raw water reservoir. The arrangement for intake of raw water to the raw water pump house shall be such that all pumps shall be operative even if either of the compartments of the reservoir is under maintenance.	

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(e) All pump houses shall be adequately equipped with drinking water and toilet facilities.		
4.8.1.2	The sub-structure of all pump houses shall be RCC with M-30 grade of concrete conforming to IS: 456. The superstructure of all pump houses shall consist of either structural steel frames or RCC portals with minimum M 25 grade of concrete.	
4.8.1.3	All pump houses shall be provided with a separate maintenance bay for maintenance of various equipment and an electrical switchgear room. Length of maintenance bay shall be adequate for one pump maintenance. Pump house where flow regulation is required, suitable steel gate stop logs along with the electrically operated hoisting arrangement shall also be provided.	
4.9	<u>PLANT WATER SYSTEM STRUCTURES/COMPONENTS</u> The description of some of the major structures/components covered under the Plant Water System Package is given below:	
4.9.1	Raw Water Treatment Plant (a) The stilling chamber aerator, flash mixer, raw water channel shall be of RCC and shall be partly underground and partly over ground. These shall be watertight structures. (b) The clariflocculators shall be of RCC construction including inlet, outlet channels & distribution chamber. (c) The sludge sump & dirty backwash sump shall be an underground RCC pit., Part of the pit shall be covered with RCC slab for supporting the vertical sludge pumps. Sludge from clarifier should be taken to ash slurry sump & Water from dirty backwash sump shall be taken to stilling chamber. For all the pump houses, roof shall be RCC form finish. Filter house building shall have RCC roof. The pump house shall be complete with brickwork, plastering, doors, windows, rolling shutters, flooring, painting and all other items necessary for satisfactory performance of the building. Brick masonry	

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wall with suitable windows and doors will be provided in accordance with Architectural concept described in Section-IV of this Volume. (d) Pretreatment chemical house shall be a two storeyed concrete framed building having chemical storage area, ozonization system in ground floor & chemical solution tank on 1st floor. The building shall be complete with brickwork, plastering, doors, windows, rolling shutters, flooring, plaster, painting, roofing, etc. and all other items necessary for satisfactory performance of the building. The building shall have toilets, drinking water overhead tank and the scope shall include supply and fixing W.C.'s urinals, showers and all plumbing sanitary and other work required for satisfactory completion of the above building. The tanks and parts of floor slabs shall be lined with Acid/Alkali proof tile lining. (e) Filtered Water reservoir shall be of watertight R.C.C. construction and form finished having two compartments covered with RCC roof form finish. It shall be partly underground and partly over ground. Vent pipes shall be provided at roof. Filtered Water reservoir including RCC roof shall be designed as uncracked structure as per IS: 3370. Food grade protective coating as per BS 1881 part I to IV shall be applied to internal surface & soffit of water reservoir. Total Capacity of Filtered water reservoir excluding freeboard shall be 45000 m³. A free board of 500mm shall be provided. Filtered Water pump house shall be complete with brickwork, plastering, doors, windows, rolling shutters, flooring, painting and all other items necessary for satisfactory performance of the building. MCC room, if required as per system design, shall also be provided. Brick masonry wall with suitable windows and doors shall be provided in accordance with Architectural concept described in Section-IV of this Volume. (f) All water tight structures shall have smooth finish in concrete and shall be given cement wash for decent appearance. All open pits at ground level shall be provided with handrail made with 32 NB galvanized pipe. All open pits shall be provided with 150 high RCC kerb. All drainage and trenches shall be provided with		

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removable RCC slab at top. These trenches at rail/road crossing, if any, shall be designed for appropriate heavy loading. For all outdoor trenches, the side walls shall project 300 mm above finished ground level. All trenches & precast RCC covers shall be provided with edge angle. (g) All E&M equipments such as pumps, blowers, centrifuge etc in water pre-treatment plant, DM Plant, Effluent Treatment Plant, Sewage Treatment Plant etc shall be provided with permanent housing arrangement with RCC roof, side cladding, flooring, doors/windows, ventilation arrangement, lifting arrangement etc." 4.9.2 CW Treatment cum Ozonization Building & Side Stream Filtration Plant: CW treatment cum Ozonization building shall be a RCC framed single storey building with brick cladding. Foundation for equipment shall be RCC construction. 4.9.3 D.M. Plant (a) Dimension and height of the building shall be decided based on equipment layout and height of the vessels accommodated inside. The DM plant building, adjoining control room and laboratory shall be provided in an RCC framed building with RCC roof form finish with brick cladding. Control room and switch gear room shall have a cable vault below. Control room and laboratory shall be air conditioned. False ceiling with gypboard shall be provided in this area. Underdeck insulation shall be provided in the A/C area as well as in the Air washer room. Staircase in the Control static room Complex shall be extended to the roof also. Flooring on Control room shall be anti-static PVC tiles. Toilet shall be provided in the ground floor. In case a transformer yard is provided, the wall in front shall be designed to satisfy fire rating as per TAC. (b) Floor where acid/alkali spillage are expected shall be isolated with RCC kerb and the flooring inside shall be of acid/alkali resistant tile. The drains inside the building carrying acid/alkali mixed discharge shall be provided with anti corrosive epoxy lining. Outside the building upto neutralising pit, these drains shall be provided with		

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Acid resistant brick lining. Specification for lining is given elsewhere in this document. Acid/alkali unloading and storage area outside the building shall also be provided with kerb with a sump inside. This area shall also be provided with Acid resistant brick lining. (c) Neutralizing pit shall be designed as a water retaining structure with external damp proofing. Floor and walls of the pit shall be given Poly propylene glass reinforced lining. Ceiling as well as floor, supporting pumps for pumping the clear water from neutralising pit shall be given heavy duty epoxy screed lining. (d) D M water storage tank outside the DM plant shall be supported on sand pad with ring wall. (e) Walls inside the DM plant area shall be provided with chlorinated rubber based painting. Main door shall be rolling shutter of adequate size to permit entry of the largest vessel. All doors and windows in the D.M. plant area shall be of aluminum glazed type. Windows shall be of sliding type. 4.9.4 Pipe/Cable Trestles and Foundations No cable/pipe trench is envisaged. All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in some localized area where the same can run in R.C.C. trenches. In case over ground routing is not feasible due to site constraints, the pipe/cable shall be routed through duct-banks. A minimum clearance (clear head room) of 8.5 m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In other areas, the clear height shall be 4.0m (minimum) from ground/grade level except in pipe corridor between main plant and plant water system which shall be 5.0m (minimum) from ground/grade level. All trestles shall be provided with continuous walkway of minimum 750mm width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc.		

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Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.5m) etc. up to the pipe/cable rack trestles. Four-legged trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch pipe rack (maximum distance 100 m) Crossover, operating platform & necessary trussed resisting arrangement at pipe bend shall be provided as required. 4.9.5 Raw water reservoir Raw water reservoir shall be developed in designated area (as shown in plot plan) for collection & storage of raw water. Storage tank shall be of RCC Construction with two compartments in which one shall be operative & other in maintenance. In case of emergency both the compartment will be operational. Sufficient freeboard shall be provided above FRL. Each compartment shall be 24000 m³ capacity. Necessary arrangement should be made in tank for in coming & outgoing & overflow pipes. The Inlet arrangement shall be such that the energy of the incoming water is sufficiently dissipated before entering the reservoir to avoid erosion and necessary concrete erosion treatment work shall be in the scope. The tank shall be provided with adequate handrails at the top bench with the 2 m wide pathway for approach/inspection/maintenance/safety purpose. Storage tank structure shall be designed as per IS-3370 & considering water level at GL. No pressure relief valve arrangement shall be considered to counter uplift pressure. 1 m wide walkway with hand railing shall be provided over the central divide wall. 4.10 <u>WASTE WATER SYSTEM STRUCTURES/COMPONENTS</u> All necessary civil/structural work for wastewater treatment plant described in Volume VI B of this specification shall be under scope of bidder. The description of some of the major structures/components covered under the Waste Water System Package is given below:		

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Coal pile area run-off shall be led to a R.C.C settling tank with two (2) compartments. Top of tank shall be 500mm above surrounding finished grade level to restrict ingress of storm water from adjacent areas. The pond shall have adequate capacity as per design requirement as specified in sec II of VOLUME VI B of this specification. At the downstream of pond, RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in Section-II of VOLUME VI B of this specification. Necessary arrangement shall be provided in inlet drain carrying coal pile area run-off so that one settling pond can be operative while the other one under maintenance. In case of exigency, both the settling tanks will be operational. The tank shall be provided with adequate handrails at the top bench with 2 m wide pathway for approach/inspection/maintenance safety purpose.

The Power House service water waste shall be collected in a RCC underground oily waste retention pit, which is also under the scope of this package. Necessary pumps and supporting floor/maintenance area shall be provided. This effluent will finally be treated in corrugated plate interceptor. Foundation for CPI shall be designed as per IS: 456.

Oil storage and handling area run-off shall be collected to a conventional baffled oil water separator of API design (battery limit shall be as shown in tender drawings). This oil water separator shall be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as uncracked section as per IS: 3370. The structure shall project at least 300mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps shall be installed.

RCC sump for collecting boiler blow down shall also be under the scope of this package. Civil work for outlet of this effluent shall also be under the Scope of this Package.

NDCT blow down, sludge drain from NDCT, C.W.floor wash, effluent from water treatment plant (pre & post) shall also be take into ETP. As far as possible, the effluent from all the sources shall be brought to ETP by gravity. Wherever the flow by gravity is not possible, the pumping arrangement with necessary piping shall be provided.

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There will be a central monitoring basin sized for holding wastewater for 8 hours (minimum) before entering into ETP. The earthen pond shall have adequate capacity as per design requirement & with 750 mm free board. Top of earthen dyke shall be 500mm above finished grade level. 2 m wide pathway shall be provided all around the pond for inspection/maintenance etc. The pond shall be of such construction as to prevent pollution of ground water by seepage of any wastewater having side slopes and bottom lined with minimum 1.0mm HDPE for minimizing seepage loss. Over the HDPE lining, PCC blocks of minimum 75mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed & provided below HDPE liner.

From Central Monitoring Basin, wastewater shall be pumped to R.C.C watertight stilling chamber partly underground & partly overground. From stilling chamber, water would be directed to High rate solid contact type clarifiers (HRSCC).

HRSCC shall be of RCC construction including inlet, outlet channels & distribution chamber. The treated water from HRSCC shall be stored in a RCC clear water storage tank. Water from storage tank shall be utilized in Ash handling plant, CHP/AHP dust suppression etc. Generated sludge shall be collected in RCC sludge sump & then pumped to ash slurry sump.

Waste water chemical house shall be a two storied concrete frame building having lifting arrangement by monorail hoist, storage area at ground floor & chemical solution tank in 1st floor. The building shall have toilets, overhead water tank. The building shall be complete with brickwork, plaster, painting, doors & windows, rolling shutter, roof etc and all other items necessary for satisfactory performance of the building. The solution tank & parts of floor slabs shall be lined with Acid/Alkali proof tile lining.

All other civil works including drains/MS pipe with fitting/RCC pipes/pipe racks including foundations etc. for successful completion and operation of waste water treatment plant shall also be done

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4.11 <u>CW AND ACW PUMP HOUSE</u> Dimensions, sizes depth of CW/ACW pump house, control building etc. if indicated in bid specification are indicative and bear minimum only. The bidder should note that the cost implication, if any, due to change in the dimension, sizing etc. as per the equipment supplier's requirement is deemed to be included in the offer. Covered R.C.C. channel from Cooling Tower basin to CW Pump House shall be minimum 500 mm above F.G.L. and road-crossing portion shall be designed for Class 'AA' traffic. 4.11.1 CW and ACW Pump House Cooling water (CW) pump house for housing cooling water pumps and auxiliary cooling water pumps shall be provided. Separate bays shall be provided for each pump by providing intermediate dividing piers /walls of RCC between the pumps. (a) (i) CW and ACW Pump Houses shall be provided with two sets of stop logs for the respective pump bay dimensions along with electrically operated hoisting arrangements. Steel embedment required for stop logs shall be provided for all bays. (ii) CW/ACW bays of pump houses shall be provided with a removable trash rack/screen including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack of respective pump bay dimension shall also be supplied for pump house. (iii) Stop logs, trash racks/screens (typ) and hoists shall be supplied in accordance with the specifications covered elsewhere, in this specification. (b) The sub-structure of CW/ACW pump houses including their fore bays shall be RCC with M-30 grade concrete conforming to IS: 456. The superstructure of all pump houses shall consist of structural steel		

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frames or RCC portals with minimum M 25 grade of concrete. The base slab and side walls of CW channel, fore bay and sump for CW/ ACW pump house shall be designed as non-cracked section. (c) CW and ACW Pump Houses shall be provided with a separate maintenance bay for maintenance of various equipment and an electrical switchgear room. Length of maintenance bay shall be adequate for one pump maintenance. However, minimum length of maintenance bay for CW pump house shall be 10 m. (i) The dimensions of the cell for CW and ACW pumps shall be governed by the guidelines of the Hydraulic institute Standards recommendations, The Contractor shall have to carry out sump model studies to ascertain smooth and laminar flow through the bell mouth thereby avoiding entry of eddies or vortices entering the pump column. The contractor shall accordingly provide special features (baffle walls, swirl prevention device, etc, based on sump model studies. The sump model studies shall be witnessed by representative of the owner and his consultant. (d) For all other structures other than the CW and ACW pump house where flow regulation is required, suitable steel flap/slucie gates shall be provided. Stop logs gates shall be provided for CW and ACW pump house. The steel flap/slucie gates/stop log gates shall be provided with self engaging and disengaging lift beams and electrically operated hoisting arrangements, as required. The steel flap /slucie gates/stop log gates shall be provided with proper rubber seal so as to avoid any leakage of water. Rubber seal provided shall be tested in accordance with the relevant Indian Standards. The stop log gates shall be checked for water tightness and smooth operation in dry and wet conditions. The leakages, if any, shall be measured and it shall not be more that 5 liters per minute per meter length of the seal under maximum head. (e) All stop logs gates and trash racks shall be of structural steel, which shall be treated for anti corrosive treatment as specified elsewhere in the tender document. The guide rails meant to facilitate raising and lowering of stop log gate/channel that are welded to guide channel		

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embedded in concrete groove or attached to the sides of stop log shall be of stainless steel grade SS-316 L conditions. All mild steel parts other than the stop logs and trash racks used in the water retaining structures shall be hot double dip galvanised and epoxy coated. The minimum coating of zinc shall be 610 gm/sq.m for galvanised structures and shall comply with IS: 4759 and other relevant codes. Galvanising shall be checked and tested in accordance with IS: 2629. The galvanising shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416. 4.11.2 Stop Logs and Screens/Trash Racks (a) Technical specification of zinc spray painting for stop log gates, screen and corresponding guides for CW pump house/raw water pump houses/other pump houses (i) Cleaning before zinc spray painting Surface of the fabricated items shall be thoroughly blast cleaned to near white metal surface as per Swedish Standard (SA 2 ½) from oil/grease. Mill scale and other loose metal deposition due to weld droppings shall to be cleaned by grinding wheels. (ii) Zinc spray painting Zinc spraying shall only be done by zinc rich paint (normally minimum 90 % m/m metallic zinc content of dry film) or by a low melting point zinc alloy within 4 hours of blasting. (iii) Minimum coating of zinc The minimum coating of zinc in zinc spraying shall be 610 gm/sq.m. Zinc shall be conforming to any grade specified in IS: 209 or IS: 13229.		

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(iv) Minimum dry film thickness - Spray painting with zinc rich primer (DFT-50 microns) to be applied within 4 hours of blast cleaning. 1st coat of finishing zinc rich spray painting (DFT-75 microns) of CORECOAT ZRC 3- component system. 2nd coat of finishing zinc rich spray painting (DFT-75 microns) of CORECOAT ZRC 3- component system. - Final coat of High Build Epoxy finish paint (DFT-100 to 150 microns) of CORECOAT FC 150. - Minimum DFT shall not be less than 300 microns. (v) Application of primer and finish coats The time interval between each coat and application procedure and other details shall be as per manufacturers specification. (vi) Freedom from defects The zinc coating shall be uniform, adherent, reasonably smooth and free from such imperfections as flux, ash patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits etc. (vii) Applicability of agreed technical specification This Technical Specification covers for zinc spray painting of Stop Log Gates, screens & corresponding guides only, other technical parameters described in Technical Specification for Civil, structural and Architectural works specified elsewhere, shall remain unaltered. (b) The stop log units shall be operated under balanced head and they shall be designed for maximum water head to which they shall be subjected to. The stop log shall be used only for the maintenance/		

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inspection of pumps. These are not to be designed for lowering under flowing water. The stop log shall be operated by means of monorail trolley with electric rope hoist and a lifting beam, which shall engage and disengage automatically with stop log in required position. Lifting beams shall be designed and fabricated by the Bidder in coordination with the manufacturer of monorail with electric hoist. The structural design of stop log shall conform to IS: 5620. (c) Trash racks shall be installed in vertical position. Trash racks shall be designed for differential head of 1 m of water column. Each unit of trash rack shall consist of vertical square bar and horizontal square bar of minimum size 10 mm square from durability point of view. The grating shall be pressure locked. Size of the openings for the trash racks shall be 100 mm x 100 mm (clear). All trash racks should be capable of being lowered in the associated stop log grooves to enable drawal of clean water while a particular trash rack is raised for cleaning purposes. Details of block-outs to be provided in structural concrete for stop logs and trash racks shall also be shown on the drawings. (d) All the design computations and drawings for the structural and mechanical parts including hoist supporting structure and connections of various components for stop logs and trash racks shall be submitted by the Bidder for approval of the Owner before the manufacture is taken up. Detailed drawings of mechanical parts such as wheels, wheel parts, hoists and various component parts of the hoists shall also be supplied along with calculations. (e) Bidder shall prepare all necessary shop drawings for the fabrication of stop log/trash rack and shall be responsible for the correct fitting of all parts. Any fabrication done before the shop drawings are approved, shall be at the Bidder's risk. The Owner shall have the right to instruct the Bidder to make any change in the Bidder's fabrication details, which may be necessary in the opinion of the Owner to make the finished construction conforming to the requirements and intent of these specifications without additional charges to the Owner. Fabrication shall conform to the requirements of the relevant Indian Standards.		

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(f) Approval of the Bidder's drawings by the Owner shall not relieve the Bidder of any part of the Bidder's responsibility to meet the requirement of these specifications, or of the responsibility for the correctness of the drawings. The Bidder shall furnish the Owner for record purposes complete sets of the final shop drawings from which the stop logs/trash racks etc. have actually been fabricated. Dimensions, tolerances, types and grades of materials and various component parts shall be shown in sufficient detail to enable the Owner to make a complete review and thoroughly check the drawings. (g) All components of stop logs and trash racks covered under this specification shall be subjected to inspection tests by Owner during manufacture at works. Shop tests shall include all tests to be carried out at Bidder's works of his sub-bidder and at works where raw materials are supplied for manufacture. The tests to be carried out shall be included but not be limited to the tests described herein. (h) Bidder shall conduct all tests according to relevant I.S. or according to relevant British/American Code of Practice in the absence of suitable I.S. Code to ensure that all the components and accessories of stop logs, trash racks, bulk heads, hoists etc. to be supplied as per the contract are confirmed to the requirements of this specification. The accessories e.g. bearings, couplings, etc. shall be subjected to tests as per Manufacture's Standard. The applicable test reports/ certificates shall be submitted to Owner. (i) Tests on motors shall be conducted as per latest revision of IS: 325 and IS: 4029. Tolerance in dimensions shall be within the limits as prescribed in the relevant I.S. Codes and Standards. Surface defects shall be removed as required by the relevant Standards. All local repairs, grinding or machining shall be smoothly blended into the surrounding surface. (j) Complete stop logs, trash racks including exposed surfaces of hoists, gear housing, shafting bearing pedestals, base plates and other machinery shall be fully galvanised. (k) After the equipment has been installed in the field, it shall be operated and tested by the Owner and when so operated and tested, it shall		

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meet all the requirements of specifications and drawings. The gates shall be raised and lowered several times for their full length of travel. The primary requirements for acceptance shall be that each stop log operates smoothly and guarantees satisfactory water tightness. Any equipment required for inspection and testing shall be provided by the Bidder and no such equipment shall be supplied by the Owner. All defects detected during testing shall be repaired to the satisfaction of the Owner. After completion of all installations, the frames and guides etc. shall be thoroughly cleaned of dirt, dust, rust and concrete spoils or other foreign materials. (l) The stop logs shall be thoroughly cleaned with particular attention being paid to bearing and seating surfaces. The mechanical hoist equipment shall be properly lubricated. Each set of stop logs, Bulkheads and Trash Racks shall be tested under dry conditions and under full water load conditions, by traversing the item concerned from its extreme raised position to full seating position and return at least thrice. (m) Upon successful completion of such tests, final acceptance shall be made by the Owner. But before a completion certificate is issued by Owner, the Bidder shall have to remove from the area of operation, on which the work has been executed, all scaffoldings, surplus materials, rubbish and other materials. If the Bidder fails to comply with this requirement, the Engineer shall get it done by other agencies at Bidder's Cost. (n) The Bidder shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in the Indian Standard Safety Code for erection of structural steel work IS : 7205. Local Statutory labour safety regulations are also applicable. (o) The Bidder shall furnish to the Owner a complete and unused set of all special tools and tackles, which are necessary or convenient for erection, commissioning, maintenance and overhauling of any of the equipment provided under the specification. The tools shall be shipped or transported in separate containers clearly marked with the name of equipment for which they are intended.		

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(p) Leakage tests shall be carried out with the stop logs lowered onto the sill. Before that observation for leakage, the stop logs shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals.

(q) Materials for the various components of Stop logs:

Sr. No.	Component parts	Recommended	Reference Materials
(i)	Stop log/Gate Leaf, Stop logs / Gate frames and embedded parts, Guide Shoe.	Structural Steel	IS : 2062
(ii)	Wheels (the hardness of wheel track surface shall be kept 50 points higher than that of wheel tread), Guide.	Cast steel	IS : 1030
(iii)	Wheel axles, wheel track	Corrosion Resistant steel	IS : 1570
(iv)	Seals	Rubber	IS : 5620 Appendix-D
(v)	Bearings	SKF or equivalent	04 Cr 19 Ni
(vi)	Seal seats, Lifting pin	Stainless Steel	IS : 1570
(vii)	Guide Rails for stop log and trash racks	Stainless Steel SS 316 L	

(r) Materials for Trash Rack shall be IS 2062.

4.12 FUEL OIL HANDLING SYSTEM

Structural arrangement, foundation system, cladding, miscellaneous requirement, finishes, etc., shall be as specified elsewhere in this specification.

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4.12.1	Transferring/Pressuring Pump House The super structure of the pressuring & transfer pump house shall be of RCC framed structure with brick cladding around these pump houses. A separate maintenance bay and MCC/Control room shall also be provided in these pump houses.	
4.12.2	Pipe/Cable Trestles and Foundations Four legged trestles and foundations are to be provided for supporting the pipelines/cables at suitable intervals. Cross overs, operating platforms and necessary thrust resisting arrangement at pipe bends shall be provided as required. 750 mm wide platform shall be provided as a walkway along the length of the trestles.	
4.12.3	RCC dyke wall of minimum 1.25m clear height above finished ground level shall be constructed around HFO & LDO day tanks as per system requirement specified in mechanical specifications for fuel handling system. All civil, structural & architectural works not specifically mentioned but required for satisfactory completion & commissioning of fuel oil handling system are included in the scope. HFO, LDO tank shall be supported on sand bitumen pad with ring wall.	
4.13	<u>AUXILIARY PLANT/NON PLANT BUILDINGS</u> List of Auxiliary plant/Non plant buildings is given in clause No.3.0 of this section. In Auxiliary plant, miscellaneous building will be of RCC construction, excepting CW and ACW pump house superstructure. In Non plant, all buildings will be R.C.C construction excepting workshop, watch tower etc. Roof of all building shall be cast-in-situ R.C.C slab with removable shuttering. Workshop, watch tower will be of structural steel construction.	

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4.14 <u>PIPE/CABLE TRESTLES AND FOUNDATIONS</u> All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in Transformer Yard area, Switchyard area and some other localized area where the same can run in R.C.C. trenches. In case over ground routing is not feasible due to site constraints, the pipe/cable to be routed through duct-banks subject to the Approval of the owner. A minimum clearance (clear head room) of 8.0m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In other areas the clear height shall be 4.0m (minimum) from ground/grade or crest of the road whichever is higher. All trestles shall be provided with continuous walkway of minimum 750 mm clear width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc. Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.0m) etc. up to the pipe/cable rack trestles. Trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch pipe rack (max. distance 100m). Crossover, operating platform & necessary thrust resisting arrangement at pipe bend shall be provided as required. 4.15 <u>ROADS</u> Main access roads to the power plant shall be from National Highway NH-6. All plant service roads of this package will be partly RCC road on sub grade and partly Bituminous concrete road laid over water bound Macadam on sub grade providing access to all truck sized building doors and all structures requiring maintenance by vehicles. Extent of different types of road shall be as shown in drawing. RCC pavement will be provided at areas requiring parking facilities. Bituminous topping of all bituminous plant road shall be done after completion of plant construction and maintenance of such road till such time shall be in scope of contractor.		

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(a) All Roads shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice. (b) For concrete road, the sub-grade shall be prepared with well-compacted selected soil/earth to achieve 95% of the standard density at optimum moisture content. Sub-base shall be 300mm thick rubble soling for filled/loose soil and 150 mm thick for cutting area (consolidated thickness). Over that 150mm thick WBM laid in two equal layers shall be applied and then dry lean concrete M-15 of 100 mm thick shall be applied. Top concrete slab shall be M-35 as per design thickness with bottom 125 micron polythene sheet. All above shall be as per 'MORTH' specification. (c) For bituminous road, the sub grade shall be prepared with well-compacted selected soil/earth to achieve 95% of the standard density at optimum moisture content. Sub base shall be 300 mm thick (consolidated thickness) with murrum/selected soil/crushed stone (grading-1), 300mm thick rubble soling for filled / loose soil and 150 mm thick for cutting area (consolidated thickness) and 100 mm thick well compacted cushion of murrum/selected soil. The wearing course shall be 75 mm thick bituminous macadam binder course with 10-12 mm seal coat laid on 150 mm thick (compacted thickness) water bound macadam course in two equal layers. (d) All roads as shown in shall have to be constructed as per the technical specification. However, additional roads and access to individual buildings/structures/facilities within scope of this specification which are not specifically shown in layout but required from functional requirement shall be provided by the Bidder. Minimum carriageway and shoulder width shall be as per the drawing enclosed with bid documents. Shoulders width shall be added to the carriageway widths to obtain minimum roadway widths.		

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	Road Type	Classification	Carriageway Width (m)	Shoulder (m)	Roadway Width (m)
		Plant access Roads			
	(i)	Primary Road with Access for 500 T crane	14.0	1.0	16.0
	(ii)	Primary Road without access for 500 T crane (internal Road)	7.0	1.5	10.0
	(iii)	access ways	5.0	0.5	6.0
	(iv)	access ways	4.0	-	4.0
Finished top (crest) of roads shall be 250mm above the surrounding grade level.					
Access roads to every system/facility are also included in the scope of work though it is not shown in Bid drawing.					
4.16	<u>SURFACE TREATMENT</u>				
4.16.1	Boiler Area				
	The entire area from Power House to Chimney shall be paved with reinforced cement concrete 150mm minimum and sloped to drains. Immediately adjacent to these areas, RCC roads shall be provided as required for access to equipment. Minimum10 mm dia. HYSD bars shall be provided at a maximum spacing of 200mm in top and bottom layer along both directions.				
4.16.2	Transformer Areas				
	Oil cooled equipment, such as transformers, shall be located within concrete basins filled with gravel along with ant weed treatment. The individual basins shall be connected by pipeline to a separate chamber/oil pit for				

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collection and further reclamation of oil through oil water separators, if necessary. Drains shall be adequate to remove full discharge from deluge system used for fire control. Transformer Yard shall be paved with reinforced cement concrete of minimum 150 mm thickness (requirement of reinforcement shall be same as given for Boiler area pavement). Rail track embedded in concrete pavement and/or roads in transformer yard for movement of transformer and in front of A row for movement of generator stator shall be in the scope of Bidder. 4.17 <u>DRAINAGE SYSTEM</u> Yard Drainage System Scope of drainage shall include following (a) Drains surrounding the buildings and systems and work area within the scope of this specification. (b) Interconnection of drains with the existing/plant water drainage system/main outfall location Drain shall be of RCC construction. Necessary structures shall be provided for crossing of roads/water ways on the way. Storm water from drainage system in Sl. No. (a) and (b) above, shall be led into Rain water harvesting pond . Drains shall be designed as a network covering the plant area as per specification. This plant area drainage shall be led into rain water harvesting pond. Attempts will be made to convert construction drains into main drain as far as practicable. Auxiliary/Branch drains shall cover individual grades to terrains; collect storm water and other non-contaminated discharge from plant buildings and then be connected to Main drain /main out fall at suitable locations. The		

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invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the main/trunk drain under all condition. RCC pipe culverts/box culverts will carry drainage under intercepting roads and railway tracks. Effluent drains shall completely be separated from storm water drain. Suitably designed underground storm water RCC piping on the basis of design loads specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view. Class of RCC pipes shall be decided by Bidder as per design requirement.

For pipe drains, concrete pipes of minimum grade – Class NP2 will be used. However, for road concrete pipes of Class NP3 will be used and for rail crossing, railway norms shall be followed. R.C.C. Manholes will be provided at maximum 30m intervals along the length, at connection points and every change of alignment, gradient or diameter of pipeline. The drains shall generally be of open type RCC rectangular construction. R.C.C. drains shall be covered with perforated R.C.C. pre-cast slab (M-25) of minimum 75mm thickness with provision of openable galvanized steel grating covers at every 4.0m intervals. Similarly, all drains along the periphery of buildings shall also have perforated R.C.C. pre-cast slab (M-25) of minimum 75mm thickness with provision of openable galvanized steel grating covers at every 4.0m intervals.

Design of such drain covers shall be done considering loading as per Cl. No. 3.1.2.1 (d) Vol. VI-A/S-II of Specification. In areas where vehicular loads would be coming, pre-cast RCC covers of suitable thickness without perforations and designed for the vehicular loads shall be provided.

In Boiler and ESP area, drains shall be provided with galvanized steel grating. For areas covering vehicular movement, pre-cast covers shall be provided. The width of the pre-cast planks shall be so designed that it can be easily handled during maintenance period.

Grating shall be as per Cl. No. 5.0 of Vol. VI/A / S-III.

The storm water drainage shall also cater for discharge of treated waste water.

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The drainage system shall be designed taking into account runoff resulting from 1 hr rainfall intensity with a return period of 100 years. These values are based on the recommendations of the Indian meteorological department. Run-off coefficient for open ground area (unpaved) shall be minimum 0.80 and for paved area and other covered surface including roads the same shall be considered as 1.0. Surface drains will normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge. RCC or masonry structures will be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box/pipe culverts. Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec. Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads Inside surface of the drain will have smooth neat cement finish over screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest main plant drainage system. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. 4.18 <u>SANITARY SEWERAGE SYSTEM</u> Sewers shall be designed for a minimum self-cleansing velocity of 0.75 m/sec and the maximum velocity shall not exceed 2.4 m/sec and shall be connected to sewerage treatment plant. Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organization, Government of India) shall be followed for design purpose. Plant effluents shall be handled in separate drains/ pipes. The plant effluent		

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drain shall not be mixed with storm water drain or sewer lines. Two types of system shall be adopted for this purpose: 1) Centralized sewage treatment plant along with pipe networking system for transfer of sanitary sewage from different plant & non-plant buildings to sewage plant inside plant boundary 2) Septic tank, up flow filter, chlorination, soak pit arrangement for the buildings (mainly at ash dyke area) required for plant operation outside plant boundary 4.18.1 Sewerage Transfer/Treatment System: Extra heavy Cast Iron pipes shall be used for sanitary work below ground as per IS: 1536. Heavy duty Cast iron pipes shall be used for sanitary work above ground level. Inspection chambers and gully trap chambers shall be in solid fly ash brick construction and manhole spacing shall not exceed 20 m. (a) System The system shall be designed on the principle of "TWO PIPE SYSTEM" having two separate vertical pipes namely Main Soil Pipe (MSP) and Main Waste Pipe (MWP) receiving waste from number of Branch Soil Pipe (BSP) and Branch Waste Pipes (BWP). A BSP either shall have only one W.C. to be connected to MSP or it shall receive discharge from number of urinals to be connected to MSP. A BWP shall receive waste from washbasins, baths, sinks, cooler areas, etc. Floor traps shall be provided to receive waste from waste pipes of various fixtures (except from W.C. which shall be directly connected to MSP) and at locations where wastewater is to be drained out.		

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A MSP shall be directly connected to first manhole of an outside sewer. A MWP shall be discharged into first manhole through a gully trap. All vertical stacks and ventilating pipes shall be carried to a height of at least 1.5 meters above parapet and shall be provided with cowl to top. (b) Sizing Minimum size of BSP receiving discharge from W.C. shall be 100 mm up to MSP/first manhole. Minimum size of BWP shall be 80 mm. Minimum size after gully trap up to first manhole shall be 100 mm. (c) Gradients: The gradient of a horizontal branch shall normally be 1 in 40 but in no case it shall be flatter than 1 in 50 and steeper than 1 in 10. Non-silting and non-scouring velocity shall be maintained. 4.18.2 Sewage Treatment Plant Centralized Sewage treatment plant is to be provided by the contractor. Anticipated number of users may be considered as 650 for design purpose. The contractor shall have to provide complete arrangement for sewage disposal up to sewage treatment plant as far as possible by gravity. Wherever, the flow by gravity is not possible, the effluent shall be transferred by pumping. All this arrangement is included in the scope. Centralized sewage treatment plant shall be with extended aeration method followed by disinfection by chlorine and necessary filtration before reuse. The contractor shall make arrangement for utilizing the treated water for gardening and plantation, along with necessary pumping and piping of required size/ capacity for recycling the treated effluent. The water generated from canteen shall also be taken in to centralized sewage treatment plant. Before canteen sludge enters the sewage treatment network pipe tank, suitable screen and oil trap shall be provided.		

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4.19 <u>AREA GRADING</u> The levelling/dressing of plant area as necessary shall be within scope of this contract. Work shall have to be carried out as per grading layout plan approved by the Owner/Owner's Consultant. 4.20 <u>FENCING</u> Fencing with gates shall be provided around transformer yard, fuel oil area and other areas wherever necessary due to security, safety, and statutory requirements as per following specifications. The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75 mm X 75 mm of height 2.4 m above the toe wall with a 600 mm high galvanised concertina at the top, such that total fence height of 3.0 m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm. The PVC coated chain link shall be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip shall be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts. Above the chain link a 600 mm high tensile serrated galvanized wire (HTSW) concertina made with wire diameter of 2.5mm shall be stretched to 6m and attached to two strands of galvanized HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands shall be attached to the fence posts with 12 mm security fasteners. All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanized. All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts shall have two stay posts and every tenth post shall have transverse stay post. Suitable R.C.C. foundations for the post and stays shall		

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be provided based on the prevailing soil conditions. All posts of fencing shall be painted with chlorinated rubber paint over a suitable primer. Toe walls either of brick masonry with bricks of minimum 50 kg/sq.cm. Crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the format on level with 50 mm thick P.C.C. coping (1:2:4) and shall extend minimum 300 mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement paint (Sand tax Matt or equivalent) of approved color and shade. Toe wall shall be provided with weep holes at appropriate spacing. 4.21 <u>GATES</u> All gates shall be of structural steel of minimum 3.75 metres clear width for single lane access road and 7.75 m clear width for double lane access roads. The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m. The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS: 513. The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel etc. 5.0 <u>DOCUMENT SUBMISSION</u> The bidder shall submit detailed design basis report for the civil structures on which designs shall be prepared and submitted for scrutiny and approval. Design and Construction documents pertaining to all Civil, Structural and Architectural works that will be required to be submitted to Owner/Owner's Consultant/Review Consultant for their approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the Contractor of his responsibility for any errors and fulfilment of Contract requirements. The actual design of individual structure shall commence only after approval of the related mechanical G. A.		

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drawing. 5.1 <u>DESIGN DOCUMENT</u> Design Document shall comprise Mechanical/Electrical assignment Drawings, design data, design basis report & references, detailed structural analysis (including computer out put, if any) & design calculations and design drawings. Design calculations and drawings shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. The contractor shall submit approved GA drawings along with three (3) copies of design documents (except design drawings) and eight (8) copies of design drawings for comments/approval of the Owner /Consultants. Soft/electronic copy of 2D and 3D analysis file and drawing shall be submitted with first submission. Procedure of approval will be as stated in Volume:II. On final approval of the drawing and design, Contractor shall submit three (3) copies of design calculation and twelve (12) copies of the drawing with one soft copy in CD each to the Owner and consultant for distribution. Soft copies of input data/STAAD file shall invariably be forwarded to the owner for scrutiny of the design calculations. The contractor shall submit related extracts of the code/standard to the owner/his consultant for ready reference in case he uses any foreign code / standard 5.2 <u>CONSTRUCTION DOCUMENT</u> Based on approved design drawing, detailed drawings for construction will be prepared by the Contractor. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall accompany each detailed drawing. For structural steel work the Contractor will prepare detailed fabrication drawing along with bill of materials. Six (6) copies each of selected or all detailed drawings/ fabrication drawings as decided by Engineer for all structures along with bar bending schedule/		

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bill of materials need be furnished to Owner/Consultants for their review and approval. Procedure of approval shall be as stated in Volume: II. Upon approval, eight (8) copies of each drawing along with one soft copy in CD shall be submitted to the Owner and Consultant for their distribution. Procedures for submission and approval of Construction Documents other than stated above have been mentioned in Volume: II and elsewhere in this specification.		
5.2.1	As Built Drawings "As-built" drawings shall be prepared by the Contractor after completion of construction/erection incorporating all the changes, if any, done on Engineer's instruction/approval. After completion of construction, Contractor shall submit eight (8) copies of all the drawings, irrespective of any changes during construction, marked "As Built" with one soft copy in CD each to the Owner.	
5.3	Guidelines for preparation and submission of drawings: (a) paper size : A0/A1 (b) Fonts : Appropriate to suit the size of the drawing	
6.0	<u>LAYOUT</u> Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and benchmark. If the Contractor uses the grid, benchmark and reference pillar made by other Contractors, he shall co-ordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and benchmark, which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.	

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If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Bidders shall take into account the cost of these in quoting their price. 7.0 <u>WORKMANSHIP</u> Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lanning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye- laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications. 8.0 <u>TEMPORARY WORK</u> All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities. The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and		

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re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor. 9.0 <u>INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE</u> Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner. 10.0 <u>SEQUENCE OF WORK AND PROGRESS REPORT</u> The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion. The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all-important items of work. The contractor shall prepare and submit the sequence of works and submit the same to the Engineer-in-charge for approval. Any changes / suggestions by the Engineer-in-charge shall be accommodated in the works scheduled and a fortnightly review shall be taken to ensure desired progress of work. The contractor on such review shall submit beforehand the programme of works he intends to take within the next fortnight for consideration and approval of the Engineer-in-charge. It shall be the responsibility of the contractor to make sure that the raw material/ingredients/equipments are available well in advance before the works are taken up. Delay on accounts of non-availability of raw material/ ingredients/equipments shall be to the contractor's account and no relief / compensation such as extension of time limit etc. shall be granted on such grounds.		

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The contractor shall arrange his procurement of structural steel elements such as plates, rolled members and reinforcement bars etc. in such a way that the works are not held up for want of these material. The owner reserves the right to change the priority of works suitable to the program of commissioning of the plant. LIST OF APPROVED VENDOR:- REFER MASTER SPECIFICATION VOLUME-II, SECTION 11		

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPP SPECIFIC TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: I
		SUB-SECTION: IB
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION – IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)

SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 1 X 660MW BHUSAWAL TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V ACDB	Vendor	Vendor	415 V AC, 3 phase, 4 wire supply/ 240 V AC, 1 phase supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor. Makes shall be subject to Customer/ BHEL approval at contract stage.
2	Local starter panel/ Push Button Station (for motors)	BHEL	Vendor	Located near the motor. Makes shall be subject to Customer/ BHEL approval at contract stage.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	a) BHEL b) BHEL/ Vendor(*) (*Refer point-3 under Remarks) c) BHEL	a) Vendor b) BHEL c) BHEL	1. Termination at BHEL equipment terminals by BHEL. 2 Termination at Vendor equipment terminals by Vendor. 3. Cables if used for aviation lighting shall be in Vendor scope.
4	Junction box for control & instrumentation cable	Vendor	Vendor	
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre Optic cables etc.	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optic cables if used between PLC/ microprocessor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system, conduits)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation drawing by vendor. 2. BHEL will provide cable trench along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands, lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Equipment grounding & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage.
9	Below grade grounding	BHEL	Vendor	MS rod material shall be provided by BHEL. All other materials/

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
10	LV Motors with base plate and foundation hardware (in case applicable for NDCT)	Vendor	Vendor	consumables are in vendor's scope. Makes shall be subject to customer/ BHEL approval at contract stage.
11	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires/ cables, any other material required for lighting system shall also be considered by vendor in their scope. BHEL will provide the power supply for LP from LDB at one location near Cooling Tower. Further distribution from LP including material is in vendor's scope.
12	Aviation Lighting	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
13	Receptacles/Industrial switch-sockets	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
14	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	<u>Engineering activities</u> during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings d. Control cable schedules showing routing details [including cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.
2. All QPs shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mismatch due to vendor's engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Wherever BHEL is indicated above, if the scope of supply and E&C of any of the above listed items is in BHEL's Customer scope, then the respective items shall be supplied, erected and commissioned by BHEL's Customer. For such items, BHEL as indicated in SUPPLY and E&C column above shall be read as "BHEL's CUSTOMER".

बी एच ई एल 	TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR NATURAL DRAFT COOLING TOWER 1 X 660 MW BHUSAWAL TPP	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION: C
		REV NO. : 00 DATE: 02.11.2018
		SHEET: 1 OF 1

TECHNICAL SPECIFICATION

FOR

NATURAL DRAFT COOLING TOWER

(ELECTRICAL PORTION)

	TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR NATURAL DRAFT COOLING TOWER 1X 660 MW BHUSAWAL TPP	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION: C
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1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER: a) Services and equipment as per "Electrical Scope between BHEL and Vendor". b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same. c) Supply of mandatory spares as specified in the specifications of mechanical equipment. d) Erection and commissioning spares. e) Erection & Maintenance tools & tackles. f) Electrical load requirement for NATURAL DRAFT COOLING TOWER. g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information. h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL. i) Various drawings, data sheet as per required format, quality plans, calculations, Type test & Routine test reports & certificates, operation and maintenance manuals, Complete technical literature with catalogues etc shall be furnished as specified at contract stage. All documents shall be subject to customer /BHEL approval without any commercial implications to BHEL. j) Motor shall meet minimum requirement of motor specification. k) LT power & control cables shall meet minimum requirement of LT power & control cables specification. l) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification. m) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications. 2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS: Refer "Electrical Scope between BHEL and Vendor". 3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following: a) A copy of this sheet "Electrical Equipment Specification for NATURAL DRAFT COOLING TOWER" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp. b) List of Erection and Commissioning spares. c) List of Erection & Maintenance tools & tackles. d) Electrical load requirement. e) If there is any conflict, customer motor specification will prevail over BHEL motor specification.		

	TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR NATURAL DRAFT COOLING TOWER 1 X 660 MW BHUSAWAL TPP	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION: C
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3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc. is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

- 4.1 Electrical scope sheet between BHEL & Vendor.
- 4.2 Customer Spec. for LV Motors.
- 4.3 General requirement of LV Motors.
- 4.4 Data Sheet - A for LV Motors.
- 4.5 Electrical Load Data Format.
- 4.6 Datasheet-C (to be filled by Vendor)
- 4.7 QP for LV motors
- 4.8 Customer Spec for Cooling Tower
- 4.9 Customer Specification for Cables
- 4.10 Customer Specification for Erection Cabling, Grounding And Lightning Protection
- 4.11 Customer Specification for Illumination
- 4.12 Customer Specification for LT Switchgear
- 4.13 QAP for Earthing and lightning protection materials
- 4.14 QAP for Illumination
- 4.15 QAP for Cable tray support-welded
- 4.16 QAP for Cable tray

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VOLUME IV-A

SECTION – 10

A.C. & D.C. MOTORS

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DATA SHEET - A AC & DC MOTOR

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1.0 <u>SCOPE</u> 1.1 This section covers the general requirements of the drive motors for power station auxiliary equipment. 1.2 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification. 1.3 In case of any discrepancy, the driven equipment specification shall govern etc. 2.0 <u>STANDARDS</u> 2.1 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/ Publications except when otherwise stated herein or in the driven equipment specification. 2.2 Major standards, which shall be followed, are listed below other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed (a) IS-325 (b) IS-12615 (c) IEC-34 3.0 <u>SERVICE CONDITIONS</u> 3.1 The motors will be installed in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash canopy to be provided to all outdoor install motors. 3.2 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure to this specification.		

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3.3	For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature	
4.0	<u>TYPE AND RATING</u>	
4.1	<u>A.C. MOTORS</u>	
4.1.1	Motors shall be general purpose, constant speed, squirrel cage, three phase, induction type.	
4.1.2	All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.	
4.1.3	The motor name-plate rating at 50°C shall have at least 10% margin over the input power requirement of the driven HT equipment at rated duty point unless stated otherwise in driven equipment specification or in general electrical specification.	
4.1.4	The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.	
4.1.5	All LT motors used in this project are proposed to be energy efficient type suitable for EFF1 efficiency rating.	
4.1.6	The motor name plate rating shall have at least 10% margin over the input power requirement of the HT driven equipment and 15% for LT driven equipments at rated duty point.	
4.1.7	Motors located in hazardous area shall be flame proof type.	
4.2	<u>D.C. MOTORS</u>	
4.2.1	D.C. Motor provided for emergency service shall be shunt/compound wound type.	
4.2.2	Motor shall be sized for operation with fixed resistance starter for maximum reliability.	

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4.2.3	Starter panel complete with all accessories shall be included in the scope of supply.	
4.3	For equipment installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in determining the design ambient temperature.	
5.0	<u>PERFORMANCE</u>	
5.1	<u>RUNNING REQUIREMENTS</u>	
5.1.1	Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.	
5.1.2	The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.	
5.1.3	The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.	
5.1.4	Motor shall not be stalled if the supply voltage drops to 70% of the rated voltage for 2 seconds duration.	
5.2	<u>STARTING REQUIREMENTS</u>	
	Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries except boiler feed pump where the starting current shall be limited to 4.5 times. No further tolerances are applicable on starting current specified above for HT motors	
5.2.1	The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage	
5.2.2	Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminal except BFP motor. In case of BFP motor, it shall	

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be 75% rated voltage. Minimum starting requirement for mill motor (double cage) shall be 85% rated voltage at motor terminals.		
5.2.3	Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition. Cranking motor shall be capable of six equally spread starts per hour, three starts in quick succession from cold condition and one restart from hot condition. The coal conveyor and crusher motors shall be suitable for 3 consecutive hot starts with maximum 20 starts per day. Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction.	
5.2.4	HT pump motors shall be suitable to start with forward rotation.	
5.2.5	The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage	
5.3	<u>STRESS DURING BUS TRANSFER.</u>	
5.3.1	The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.	
5.3.2	The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.	
5.4	<u>LOCKED ROTOR WITHSTAND TIME</u>	
5.4.1	The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 2.5 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.	

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5.4.2	Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.	
5.4.3	Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilizing motor rated capacity	
6.0	<u>SPECIFIC REQUIREMENTS</u>	
6.1	<u>ENCLOSURE</u>	
6.1.1	All indoor motor enclosures shall conform to the degree of protection IP-55 unless otherwise specified and outdoor motor enclosure shall confirm to degree of IPW-55. Motor for outdoor or semi-outdoor service shall be of weather-proof construction.	
6.1.2	For hazardous area approved type of increased safety enclosure shall be furnished.	
6.2	<u>COOLING</u>	
6.2.1	The motor shall be self ventilated type, either totally enclosed fan cooled (TEFC) or closed air circuit air- cooled (CACA).	
6.2.2	In case water cooling is required for very large motors, prior approval of the customer is to be obtained before proceeding ahead with design & manufacture.	
6.3	<u>WINDING AND INSULATION</u>	
6.3.1	All insulated winding shall be of copper.	
6.3.2	All motors shall have class F insulation but limited to class B temperature rise.	
6.3.3	Windings shall be impregnated to make them non-hygroscopic and oil resistant.	

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6.4 <u>TROPICAL PROTECTION</u> 6.4.1 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion. 6.4.2 All fittings and hardwares shall be corrosion resistant. 6.5 <u>BEARINGS</u> 6.5.1 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. 6.5.2 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. 6.5.3 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area. 6.5.4 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves. 6.5.5 Grease lubricated bearings shall be prelubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication. 6.5.6 Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs. 6.5.7 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner. 6.5.8 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent. 6.5.9 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.		

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6.6	<u>NOISE & VIBRATION</u>	
6.6.1	The noise level shall be as per statutory acceptance (IS/IEC).	
6.6.2	The peak amplitude of the vibration shall be within IS/IEC specified limits.	
6.7	<u>MOTOR TERMINAL BOX</u>	
6.7.1	Motor terminal box shall be phase segregated (PSTB) type and located in accordance with Indian Standards clearing the motor base- plate/ foundation.	
6.7.2	Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. For HT motors and 90 Deg. for LT motors unless otherwise approved.	
6.7.3	The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.	
6.7.4	The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.	
6.7.5	Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.	
6.7.6	The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.	
6.7.7	The terminal box shall be capable of withstanding maximum system fault current for duration of 0.25 sec.	
6.7.8	For 11kV and 3.3kV motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.	
6.7.9	Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.	
6.7.10	The gland plate for single core cable shall be non-magnetic type.	

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6.7.11 Due to any reason, if the terminal box is found to be not suitable for the approved cable size for either HT/LT motors, then the bidder shall arrange necessary adopter box to facilitate the termination of cables. The adopter box shall be of the same short circuit rating and specifications as the main terminal box. The adopter box shall be located as near as possible to the main terminal box. The interconnecting cabling between adopter box and main terminal box along with providing suitable cable glands and termination kits as applicable shall also be done by the bidder.

6.8 GROUNDING

6.8.1 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GS bolts and washer

6.8.2 The grounding connection shall be suitable for accommodation of ground conductors as follows :

Motor above 90 kW : 75 x 10 mm GS Flat

Motor above 30 kW up to 90 kW : 50 x 6 mm GS Flat

Motor above 5 kW up to 30 kW : 25 x 6 mm GS Flat

Motor up to 5 kW : 8 SWG GS Wire

6.8.3 The cable terminal box shall have a separate grounding pad

6.9 RATING PLATE

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate:

(a) Temperature rise in Deg.C under rated condition and method of measurement.

(b) Degree of protection.

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(c) Bearing identification no. and recommended lubricant. (d) Location of insulated bearings. 6.10 <u>CONSTRUCTION</u> 6.10.1 Stator Core The Stator Core Lamination shall be made of high-grade silicon/magnetic steel sheet varnished on both sides and pressed to form rigid core. 6.10.2 Rotor The rotor construction shall be such that in case of dislodging of the rotor bar from the end ring, it should not come out and hit the stator core/stator winding and damage. 7.0 <u>ACCESSORIES</u> 7.1 <u>GENERAL</u> Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application 7.2 <u>SPACE HEATER</u> 7.2.1 Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement. 7.2.2 The space heater shall be rated 240 V, 1 phase 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. 7.3 <u>TEMPERATURE DETECTORS</u> 7.3.1 All 11kV and 3.3kV motors shall be provided with twelve (12) nos. Simplex type winding temperature detectors, four (4) nos. per phase.		

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7.3.2	11kV and 3.3kV motor bearing shall be provided with duplex type temperature detectors.	
7.3.3	The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.	
7.3.4	Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS connectivity.	
7.3.5	Five numbers of Temperature detectors / thermistors shall be provided for L.T. Motors above 90 kW (3 nos. Winding temperatures & 2 nos. bearing temperatures).	
7.4	<u>INDICATOR/SWITCH</u>	
7.4.1	Dial type local indicator with alarm contacts shall be provided for the following :	
	(a) 11kV and 3.3kV motor bearing temperature	
	(b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor	
7.4.2	Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.	
7.4.3	Alarm switch contact rating shall be minimum 0.5 A at 220V D.C. and 5A at 240V A.C.	
7.5	<u>CURRENT TRANSFORMER FOR DIFFERENTIAL PROTECTION</u>	
7.5.1	Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 nos. CT for mounting on switchgear side shall be in bidder's scope.	

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7.5.2	The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.	
7.6	<u>ACCESSORY TERMINAL BOX</u>	
7.6.1	All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.	
7.6.2	Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit cable connections.	
7.7	<u>DRAIN PLUG</u>	
	Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.	
7.8	<u>LIFTING PROVISIONS</u>	
	Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.	
7.9	<u>DOWEL PINS</u>	
	The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.	
7.10	<u>PAINTING</u>	
	Motor including fan shall be painted with corrosion proof paints of colour shade (RAL-7032).	
8.0	<u>TESTS</u>	
8.1	<u>ROUTINE AND TYPE TEST:</u>	

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Tests are to be conducted for HT and LT motors 60kW and above in presence of Mahagenco representative and contractor as per IS: 325 and required copies of test certificates are to be furnished for approval and despatch clearance. In addition, following tests shall have to be carried out on the motors in presence of MAHAGENCO representative & contractor on LT & HT motors. For Motors below 60kW type and routine test conducted as per IS325 shall be witnessed by contractor and test certificate shall be submitted for review of Mahagenco & Dispatch clearance

8.1.1 FOR HT MOTORS:

(a) Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-671/IS 14422,1995 test voltages as under

Voltage rating of motor	Impulse Test Voltage
3.3 kV	: 18 kV peak
11 kV	: 49 kV peak

(b) Tan delta, charging current and dielectric loss measurements on each phase of motor stator winding as routine test

(c) Polarization Index Test as per IS:7816 as routine test

(d) Tan delta measurement on coils

(e) Surge withstand test for inter turn insulation.

(f) Test to diagnose rotor bar failure during manufacture.

Tests indicated at (d), (e), (f) shall be carried out during manufacture of the coils and shall be furnished for verification .

8.1.2 FOR HT & LT MOTORS:

(a) Test for suitability of IP55/ IPW– 55 as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test,

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provided the test motor is identical to motor being supplied. Second numeral test shall be carried out on one motor of each type and rating. (b) Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box within last three years. (c) Test for noise level as routine test. (d) Test for vibration as routine test. (e) Overspeed test as type test. 8.2 <u>TEST WITNESS:</u> 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.		

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<u>AC & DC MOTOR</u> <u>DATASHEET – A</u>			
SR. NO.	ITEM	UNIT	
1.0	<u>AUXILIARY POWER SUPPLY</u>		
1.1	<u>H.T. SUPPLY</u>		
	11kV, 3Ø, 3W, 50 Hz non-effectively earthed		Motors rated 1000 kW and above
	Fault level 44 kA symm		
	3.3kV, 3Ø, 3W, 50 Hz, non-effectively earthed		Motors above 160 kW and below 1000kW
	Fault level 40 kA symm		
1.2	<u>L.T. SUPPLY</u>		
	415V, 3Ø, 3W, 50 Hz effectively earthed		Motors below and including 160kW
	Fault level 50 kA symm		
	240V, 1Ø, 2W, 50 Hz effectively earthed		Lighting, space heating, A.C. control & protective devices
1.3	<u>D.C. SUPPLY</u>		
	220V, 2W, unearthed		D.C. alarm, control & protective devices
	Fault level 25* kA.		
	Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation		
2.0	<u>RANGE OF VARIATION</u>		

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2.1	<u>A.C. SUPPLY:</u>		
	Voltage		± 10%
	Frequency		± 5%
	Combined Voltage & frequency		± 10% (absolute sum)
	During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance		
2.2	<u>D.C. SUPPLY</u>		
	Voltage		198 to 240 Volt

CONSULTANT : PROCON ENGINEERS

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
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		SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. : II-B
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1.0

INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer’s work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0

CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0

DESIGN REQUIREMENTS

3.1

Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2

Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3

Starting Requirements

3.3.1

Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2

Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

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		REV NO. : 00 DATE :
		SHEET : 2 OF 4
The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.		
3.3.3 The following frequency of starts shall apply		
i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.		
ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)		
iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor		
3.4 Running Requirements		
3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.		
3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.		
3.5 Stress During bus Transfer		
3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.		
3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.		
4.0 CONSTRUCTIONAL FEATURES		
4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy		
4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.		
Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE :
		SHEET : 3 OF 4
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

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4.9.1 Motors provided for similar drives shall be interchangeable. 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors. 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above. 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956. 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz. 4.9.6 Name plate with all particulars as per IS: 325 shall be provided 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. 5.0 INSPECTION AND TESTING 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied. 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser. 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan. 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A. 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT a) OGA drawing showing the position of terminal boxes, earthing connections etc. b) Arrangement drawing of terminal boxes. c) Characteristic curves: (To be given for motor above 55 kW unless otherwise specified in Data Sheet). i) Current vs. time at rated voltage and minimum starting voltage. ii) Speed vs. time at rated voltage and minimum starting voltage. iii) Torque vs. speed at rated voltage and minimum voltage. For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling. iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.		

	TITLE LV MOTORS <u>DATA SHEET-A</u>	SPECIFICATION NO.	
		VOLUME	II B
		SECTION	D
		REV NO. 00	DATE 15.01.18
		SHEET 1	OF 1

1.0	Design ambient temperature	:	50° C
2.0	Maximum acceptable kW rating of LV motor	:	Motors up to 160 kW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP55/ IPW55
5.0	Type of Cooling	:	TEFC/CACA
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% to -5%)
	c) Combined voltage & freq. variation	:	10% (absolute sum)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F' with temp rise limited to class B
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1 Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 kW
13.0	Tests	:	As per Customer motor spec.(enclosed)
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement
14.0	Makes	:	As per Annexure-I

NOTE:
1. Also detail Customer spec. for Motors is to be referred as enclosed with technical spec.

ANNEXURE-I

SUB-VENDOR LIST

The list of approved make of the LT Motors are as mentioned below:

S.No.	LIST OF LT MOTORS
1.	BHARAT BIJLEE LTD.
2.	CROMPTON GREAVES
3.	ASEA BROWN BOVERI
4.	KIRLOSKAR ELECTRIC CO LTD.
5.	NGEF
6.	SIEMENS
7.	MARATHON
8.	GE-POWER
9.	RAJINDRA ELECT INDUSTRIES
10.	LAXMI HYDRAULICS PVT. LTD

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

[illegible]

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB)		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE LV MOTOR DATA SHEET - C	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO.00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) Suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :		
				BIDDER/ :		TITLE		NUMBER :		
				VENDOR		QUALITY PLAN		TITLE		
				SYSTEM		ITEM ELECTRICAL N-PROCESS		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	10	11
1.0	FABRICATION	1. DIMENTION 2.ALIGNMENT 3. FINISH SURFACE DEFECT	MA MA MA	MEASUREMENT MEASUREMENT & VISUAL VISUAL	100% 100% 100%	APPD. DRG. -DO- -DO-	APPD. DRG. -DO- -DO-	INSPC. -DO- -DO-	2 2 2	- - -
2.0	SURFACE PREPARATION & PRE-TREATMENT	1. PROCESS PARAMETERS SOLUTION STRENGTH TEMPERATURE DIPPING TIME ETC. 2. SURFACE CONDITION	CR MA	PROCESS VISUAL	PERIODIC 100%	MFR.STD./ BHEL SPEC. RELV. IS -DO-	MFR. STD./ BHEL SPEC RELV. IS -DO-	LOG BOOK -DO-	2 2	- -
3.0	PRIMER & PAINTING (SPRAYED & STOVED)	1. SURFACE FINISH & COVERAGE 2. FILM THICKNESS 3. SHADE 4. ADHESION	MA MA MA MA	VISUAL VISUAL MEASUREMENT VISUAL CROSSOUT TYPE	100% 100% SAMPLE -DO- -DO-	-DO- -DO- -DO- -DO- -DO-	-DO- -DO- -DO- -DO- -DO-	-DO- -DO- -DO- -DO- -DO-	2 2 2 2 2	- - - - -
BHEL		PARTICULARS		BIDDER/VENDOR						
		NAME								
		SIGNATURE								
		DATE				BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :				
SHEET 2 OF 2		BIDDER/ VENDOR SYSTEM		TITLE		NUMBER :		SPECIFICATION :				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY			VOLUME III REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
4.0	MOUNTING OF VARIOUS ITEMS	1. RIGIDITY	MA	VISUAL	100%	MANUFACTURE DRAWING	MANUFACTURE DRAWING	LOG BOOK				
		2. THICKNESS	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
		3. CORRECTNESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG.	APPD. DRG.	-DO-	2	-	-	
		4. ACCESSIBILITY	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
5.0	MARKING/LABELLING	1. CORRECTNESS	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
		2. ADHESION/ FIXING	MA	VISUAL	100%	-DO-	-DO-	-DO-	2	-	-	
6.0	PRE-FINAL INSPECTION	1. ALIGNMENT	MA	VISUAL	100%	BHEL SPEC. & RELV. STD.	BHEL SPEC. & RELV. STD.	TEST CERT.	2	-	-	
		2. PERFORMANCE	MA	ELECTRICAL	100%	-DO-	-DO-	-DO-	2	-	-	
		3. IR & HV	MA	ELECTRICAL	100%	-DO-	-DO-	-DO-	2	-	-	
BHEL												
PARTICULARS												
NAME												
SIGNATURE												
DATE												
BIDDER'S/VENDORS COMPANY SEAL												

BHEL				CUSTOMER/		TSPGCL		PROJECT		1 X 660 MW BHUSAVAL TPS		SPECIFICATION :							
QUALITY PLAN				BIDDER/ VENDOR		TITLE		QUALITY PLAN		NUMBER PED-506-Q-007, REV-03		SPECIFICATION :							
SHEET 1 OF 9				SYSTEM		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		TITLE							
COMPONENT/OPERATION				CAT.		CHECK		CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		SECTION		VOLUME III	
SL. NO.	CHARACTERISTIC CHECK			CHECK		CHECK		CHECK		CHECK		CHECK		CHECK		CHECK		REMARKS	
				3		4		5		6		7		8		9		10	
1	2			1		2		3		4		5		6		7		8	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL																		
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS			1.SURFACE CONDITION		MA		VISUAL		100%		-		FREE FROM BLINKS, CRACKS, WAVINESS ETC		LOG BOOK		3 - -	
				2.DIMENSIONS		MA		MEASUREMENT		SAMPLE		MANFR'S DRG./SPEC		-DO-				3 - -	
				3.PROOF LOAD TEST (EYE BOLT)		MA		MECH. TEST		-DO-		-DO-		INSPEC. REPORT				3 - 2	
1.2	HARDWARES			1.SURFACE CONDITION		MA		VISUAL		100%				FREE FROM CRACKS, UN-EVENNESS ETC.		-DO-		3 - -	
				2.PROPERTY CLASS		MA		VISUAL		SAMPLES		MANFR'S DRG./SPEC BOOK		RELEVANT IS/SPEC.		SUPPLIERS TC & LOG		3 - 2	
1.3	CASTING			1.SURFACE CONDITION		MA		VISUAL		100%				FREE FROM CRACKS, BLOW HOLES ETC.		LOG BOOK		3 - 2	
				2.CHEM. & PHY. PROP.		MA		CHEM & MECH TEST		1/HEAT NO.		MANFR'S DRG./SPEC		RELEVANT IS/TC		SUPPLIERS TC		3 - 2	
				3.DIMENSIONS		MA		MEASUREMENT		100%		MANUF'R'S DRG.		LOG BOOK				3 - 2	
1.4	PAINT & VARNISH			1.MAKE, SHADE, SHELF LIFE & TYPE		MA		VISUAL		100% CONTINUOUS		MANFR'S DRG./SPEC		LOG BOOK				3 - 2	
BHEL				PARTICULARS		BIDDER/VENDOR													
				NAME															
				SIGNATURE															
				DATE															

				CUSTOMER/	TSPGCL	PROJECT	1 X 660 MW BHUSAWAL TPS	SPECIFICATION :					
QUALITY PLAN				BIDDER/	:	TITLE		NUMBER :					
SHEET 2 OF 9				SYSTEM		QUALITY PLAN	NUMBER PED-506-00-Q-007_REV-03	TITLE					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	VOLUME III REMARKS			
1	2	3	4	5	6	7	8	9	P	W	V	10	11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND. 2. CHEM. & PHYSICAL PROPERTIES 3. DIMENSIONS 4.INTERNAL FLAWS	MA MA MA CR	VISUAL CHEM. & PHYSICAL TESTS MEASUREMENT UT	100% 1/H EAT NO. OR H EAT TREATMENT BATCH NO 100% -DO-	- MFG. DRG. SPEC. -DO- ASTIM-A388	FREE FROM VISUAL DEFECTS RELEVANT IS MANUF'R'S DRG. MANUF'R'S SPEC. BHEL SPEC.	-DO- SUPPLIER'S TC LOG BOOK -DO-	3 3 3 3	- - - 2	- 2 2 1	- - - 2	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING 2. PHYSICAL COND. 3.DIMENSIONS (WHEREVER APPLICABLE) 4 PERFORMANCE/ CALIBRATION	MA MA MA	-DO- MEASUREMENT TEST	-DO- SAMPLE 100%	- MANUF'R'S DRG./ SPEC. -DO-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY MANUF'R'S DRG. / SPEC. -DO-	-DO- -DO- INSP REPORT	3 3 3	- - - 2	- - - 2	- - - 2	
BHEL				PARTICULARS		BIDDER/VENDOR							
				NAME									
				SIGNATURE									
				DATE									
				BIDDER/VENDORS COMPANY SEAL									

		QUALITY PLAN		CUSTOMER: TSPGCL		PROJECT: 1 X 660 MW BHUSAWAL TPS		SPECIFICATION : NUMBER :					
		SHEET 3 OF 9		BIDDER/ VENDOR SYSTEM		QUALITY PLAN		SPECIFICATION : TITLE					
		SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY		VOLUME III REMARKS
											P	W	
1	2	3	4	5	6	7	8	9	10		11		
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC. 2. OTHER CHARACTERISTICS	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	FOR MV MOTOR INSULATION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT	
			MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2		
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-		
		2.DIMENSIONS INCLUDING BURS HEIGHT 3. ACCEPTANCE TESTS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG. .	MANUF'S DRG.	-DO-	3	-	2		
1.9	CONDUCTORS	1. SURFACE FINISH 2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH. TESTS	-DO- 100%	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2		* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
			MA	VISUAL		-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*		
BHEL			MA	ELECT. & MECH. TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2		
PARTICULARS			BIDDER/VENDOR										
NAME													
SIGNATURE													
DATE													
			BIDDER/S VENDORS COMPANY SEAL										

		QUALITY PLAN		CUSTOMER/ TSPGCL	PROJECT TITLE	SPECIFICATION :					
						NUMBER :					
						SPECIFICATION :					
SHEET 4 OF 9		BIDDER/ VENDOR SYSTEM		QUALITY PLAN		TITLE					
COMPONENT/OPERATION		CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION	VOLUME III	
SL. NO.									AGENCY	REMARKS	
									P	W	V
1	2	3	4	5	6	7	8	9	10	11	
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	MANFR'S DRG./ APPROVED DATASHEET	-DO- MANFR'S DRG./ APPROVED DATASHEET	Log Book	3	-	2
		1.MAKE & TYPE	MA	VISUAL	100%		BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE		FREE FROM VISUAL DEFECTS	-DO-	3	-	2
		3.SURFACE FINISH	MA	VISUAL	100%		-DO-		3	-	2
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%		-DO-	-DO-	3	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2
		4.HV/IR	MA	-DO-	100%		-DO-	-DO-	3	-	2
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-
		2.SURFACE COND.	MA	VISUAL	100%		FREE FROM VISUAL DEFECTS	-DO-	3	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
				BIDDER'S/VENDORS COMPANY SEAL							

QUALITY PLAN		CUSTOMER/	TSPGCL	PROJECT TITLE		SPECIFICATION : NUMBER :							
SHEET 5 OF 9		BIDDER/ VENDOR	QUALITY PLAN NUMBER PED-506-00-Q-007. REV-03		SPECIFICATION : TITLE								
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SYSTEM	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			REMARKS
										AGENCY	P	W	
1	2	3	4	5	6	7	8	9	10	11			
2.0	IN PROCESS												
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-		
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-		
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-		
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-		
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ASTM-E165	MANUF'S SPEC./BHEL SPEC./	-DO-	2	-	1		
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ SAME AS RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-		
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-		
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-		
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-		
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
									BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER/	TSPGCL	PROJECT TITLE		1 X 660 MW BHUSAWAL TPS		SPECIFICATION : NUMBER :	
SHEET 7 OF 9		BIDDER/ VENDOR		SYSTEM CAT.		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SPECIFICATION : TITLE	
										SECTION	
										VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	EXTENT OF CHECK	TYPE/ METHOD OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY		REMARKS	
								P	W	V	
1	2	3	4	5	6	7	8	9	10	11	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1
		1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2	1	1
2.9	COMPLETE ROTOR ASSEMBLY	3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	1	1
		1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2	1	1
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2	1	1
		1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-
		5.CORRECTNESS, COMPLETENESS, TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	1	1
BHEL				PARTICULARS		BIDDER/VENDOR					
				NAME							
				SIGNATURE							
				DATE							

		QUALITY PLAN		CUSTOMER: TSPGCL		PROJECT TITLE		SPECIFICATION : NUMBER :						
				BIDDER/ VENDOR SYSTEM		QUALITY PLAN NUMBER PED-506-Q-007, REV-03		SPECIFICATION : TITLE		VOLUME III				
SL. NO.	COMPONENT/OPERATION	SHEET 8 OF 9	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	REMARKS			
										P	W	V		
1	2	3	4	5	6	7	8	9	10	11				
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC. 2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC. 3.VIBRATION & NOISE LEVEL 4.OVERALL DIMENSIONS AND ORIENTATION 5.DEGREE OF PROTECTION 6. MEASUREMENT OF RESISTANCE OF RTD & BTD 7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER 8. NAMEPLATE DETAILS 9.EXPLOSION FLAME PROOF TEST (IF SPECIFIED) 10. PAINT SHADE, THICKNESS & FINISH	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT. TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1	
			2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
			3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
			4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-		
			5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1		TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
			6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
			7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	-DO-	2	1 ^s	1	\$ NOTE - 2
			8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^s	1	\$ NOTE - 2	
			9.EXPLOSION FLAME PROOF TEST (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1		TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
			10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^s	1		SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2
BHEL				PARTICULARS	BIDDER/VENDOR									
				NAME										
				SIGNATURE										
				DATE										
				BIDDER/SVENDORS COMPANY SEAL										

		QUALITY PLAN		CUSTOMER	TSPGCL	PROJECT TITLE		1 X 660 MW BHUSAWAL TPS		SPECIFICATION : NUMBER :	
				BIDDER/ VENDOR			QUALITY PLAN		SPECIFICATION : TITLE		
				SYSTEM			NUMBER PED-506-00-Q-007, REV-03				
				CAT.			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)				
				CHARACTERISTIC CHECK			REFERENCE DOCUMENT		AGENCY		VOLUME III
							EXTENT OF CHECK		P		W
							METHOD OF CHECK		V		
							CHECK		10		11
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SECTION –14

NDCT-ELECTRICAL WORKS

CONSULTANT : PROCON ENGINEERS

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CONSULTANT : PROCON ENGINEERS

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1.0	SCOPE OF WORK
2.0	DISTRIBUTION BOARDS
3.0	DAY MARKING AND AVIATION WARNING LIGHTS
4.0	INTERIOR AND EXTERIOR LIGHTS
5.0	CABLES AND CONDUITS
6.0	GROUNDING
7.0	LIGHTNING PROTECTION
8.0	TESTS

CONSULTANT : PROCON ENGINEERS

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CONSULTANT : PROCON ENGINEERS

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1.0 SCOPE OF WORK

1.1 The scope of supply and services shall include but not be limited to the following for NDCT :

- (a) Equipment and materials as required.
- (b) All relevant drawings, data and instruction manuals.
- (c) Recommended spares for three (3) years of operation.
- (d) Erection, testing and commissioning of all electrical equipment and materials supplied under this specification.
- (e) Obtaining statutory approvals for Aviation warning system from concerned authority.

1.2 NDCT shall be provided with but not be limited to the following :

- (a) Normal and Emergency Power distribution and control system
- ~~(b) Electrical system for Elevator~~
- (c) Aviation Obstruction Lighting system
- (d) Normal and Emergency Lighting system
- (e) Cabling and conduit system including supply, laying & termination of all cables.
- (f) Earthing system
- (g) Lightning protection system
- (h) All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary.

CONSULTANT : PROCON ENGINEERS

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1.3 POWER SUPPLY

1.3.1 Bidder shall manage the following power supply for NDCT including supply, laying and termination of the cable for the below power supply :

- (a) One (1) 415 V $\pm$ 10%, 3 phase, 4 wire, 50 Hz $\pm$ 5% (fault level 50 KA) supply to Main Distribution Board for Normal AC Lighting, Aviation Lighting ~~and elevator.~~
- (b) One (1) 415 V $\pm$ 10%, 3 phase, 3 wire, 50 Hz $\pm$ 5% (fault level 50 KA) supply from emergency source Board of T.G. Building to Lighting board for Emergency lights and Aviation Warning Lights and elevator.

Any other, supply voltage, if required for the electrical system, the same shall be arranged by the Contractor through suitable means as necessary without any price implication.

1.3.2 From normal to emergency Automatic changeover with suitable delay timers with Auto / Manual operation shall be provided by the bidder.

The emergency power supply to NDCT & NDCT emergency power distribution shall be by LT XLPE Power cables.

2.0 DISTRIBUTION BOARDS

2.1 MAIN POWER DISTRIBUTION BOARDS

One (1) Main Power Distribution Board (MPDB) shall be provided for feeding lighting distribution boards, ~~elevator~~ and power receptacles. This Main Power Distribution Board shall be located at EL 0.0 m inside the concrete shell of the NDCT. The incoming to the MPDB shall be suitable for 415V, 3 phase, 4-wire 50 Hz supply. 10% spare feeders with minimum one (1) of each type and rating shall be provided.

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2.2 LIGHTING BOARD

One (1) lighting board shall be provided for Normal A.C. Lighting and one (1) Lighting board shall be provided for Emergency A.C light and Aviation Warning lighting system. This lighting board shall also be located at El. 0.0m. Each lighting distribution board shall be provided with an adequately rated dry type, delta/star, lighting transformer with Z=5% and off circuit taps for variation from -5% to +5% in steps of 2.5% on the primary side. The star point of the secondary side shall be solidly grounded to get the 3 phase, 4 wire supply required for the lighting distribution board. The lighting distribution boards shall have 10% with minimum two (2) spare feeders of each type and rating.

The dry type transformer shall have the following properties:

- (a) Insulation class of lighting transformer shall be "F"
- (b) Temperature rise shall be limited class "B".
- (c) The transformer shall be cast resin type.

2.3 MAIN POWER DISTRIBUTION BOARD / LIGHTING BOARD CONSTRUCTIONAL DETAILS

- 2.3.1 Main Power Distribution Board (MPDB) and Lighting Boards shall be metal enclosed, fabricated from CRCA sheet steel minimum 2 mm thick. Main Power Distribution Board shall be modular construction, fixed type module, floor-mounted and free-standing type. Each module of MPDB shall be provided with hinged door. Lighting Boards shall be suitable for either wall/column mounting on brackets or floor mounting on channel sills with hinged door on the front.
- 2.3.2 Main Power Distribution Board and Lighting Boards shall be dust and vermin-proof, IP-54 or better.
- 2.3.3 Main Power Distribution Board and Lighting 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.

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2.3.4	Main Power Distribution Board and Lighting Boards shall have provision of cable entry from bottom as required, with removable gland plates. Necessary double compression type brass cable glands, heavy duty tinned copper cable lugs (for aluminium and copper conductor) shall be furnished by the Contractor.	
2.3.5	Two ground pads with M10 G.S. bolts and nuts shall be provided on Main Distribution Board and Lighting Boards for connection to 70mmx10mm G.S. flat.	
2.3.6	Main Power Distribution Board shall be complete with designation and caution notice plates fixed at front and backside and feeder nameplate fixed on the front cover. Each Lighting Board shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of the circuit. The plates shall be of anodized aluminium with inscriptions indelibly etched on it.	
2.3.7	Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85 Deg°C.	
2.3.8	Incoming and outgoing circuits shall be terminated in suitable terminal blocks.	
2.3.9	Main Power Distribution Board shall consist suitable rated switch fuse for over load and short circuit protection for incomer, voltmeter with selector switch and suitable PT, C.T. Operated ammeter. Outgoing feeder from the Main Power Distribution Board shall also have switch fuse with a over load and short circuit release. It is the Contractor's responsibility to ensure proper discrimination between outgoing switch fuse of Main Power Distribution Board and downstream MCB of Lighting Boards.	

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2.3.10	Each Lighting Board shall have an incoming triple pole switch fuse with over load and short circuit release. Lighting transformer and a number of outgoing miniature circuit breakers (MCB), 9 kA rating. The lighting transformer shall be dry type housed in the cubicle.	
2.3.11	Access door of Main Power Distribution Board and Lighting Board shall be interlocked with incoming switch fuse unit such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.	
2.3.12	MCBs (9 kA rating) in lighting boards shall be suitable for manual closing and opening and automatic trip on overload and short circuit.	
2.3.13	Main Power Distribution Board and lighting boards, after application of primer, shall be finished with electrostatic or powder painting process (thickness not less than 50 microns). The colour of exterior shade shall be light grey (Shade 631 of IS 5).	
3.0	<u>DAY MARKING AND AVIATION WARNING LIGHTS</u>	
3.1	<u>DAY MARKING</u>	
3.1.1	The external surface of the NDCT shall be painted with horizontal strips as per IC.AO recommendation. Alternate bands of aviation red and aviation white paint shall be provided. Quality paint and materials should be selected, subject to Owner's approval, to provide extra years of service. The paint should be compatible with surfaces to be painted, including any previous coatings, and suitable for the environmental conditions. Surface preparation and paint application should be in accordance with manufacturer's recommendation.	
3.2	<u>AVIATION WARNING LIGHTS</u>	
3.2.1	The aviation warning lights are required to be provided at various levels. The number of obstruction lights to be installed at specified level shall be such that the obstruction is indicated from every angle in the azimuth. Fixtures on each level shall be arranged at the same elevation and with equal radial spacing around the NDCT. The aviation warning lights shall be supplied complete with all accessories and control unit.	

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The aviation warning lights shall be high power light emitting diodes (LED) and to be installed on NDCT shall be as follows: (a) Medium intensity (>1600 cd) red flashing lights (20-60 flashes per minute, adjustable) above height of 61 M. (b) Low intensity (>10 cd) steady lights below 61 M. 3.2.2 The top most lights shall be placed between 3M to 5M below the top of NDCT and the rest at each platform level. The lights shall be spaced equally with minimum four (4) numbers around the NDCT. 3.2.3 The aviation warning lights shall be adequately secured to the NDCT against wind forces and shall be mounted so that they are accessible for lamp replacement and cleaning. 3.2.4 The lighting system shall be energized through an adjustable timer (0-24 hrs). The timer shall cause the control unit to energize and de-energize the aviation lighting system automatically as per the preset time. In addition auto-manual selection with manual ON-OFF facility of the lights shall be provided in the control unit. 3.3 <u>TEMPORARY AVIATION WARNING LIGHTS</u> 3.3.1 The temporary aviation warning lights shall be provided during construction. Lights shall be provided on the upper most part of the NDCT or the surrounding scaffolding and form work as construction proceeds upward. As each level specified to have permanent aviation warning lights is passed, that level shall be provided with temporary aviation warning lights. 3.3.2 Temporary aviation warning lights shall be four fixtures each with not less than 10 foot candles of the type (LED type) specified located in a horizontal plane on the NDCT structure to ensure unobstructed visibility of at least one aviation warning light from aircraft at any normal angle of approach. Power for operation of the temporary aviation warning lights shall be obtained from the construction power system. Supply circuits for these lights shall be furnished, installed and maintained by the Contractor.		

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3.3.3 3.3.4 4.0 4.1 4.2 4.3 ~~4.4~~	Temporary aviation warning lights shall be operated nightly from sun set to sun rise. The lights shall continue to exist till permanent arrangements of lights are completed. Contractor shall furnish along with the bid, design calculations, technical literature/ pamphlets and drawings for each item of NDCT aviation lighting system. <u>INTERIOR AND EXTERIOR LIGHTS</u> Interior platforms and staircase shall be illuminated by LED type industrial well glass luminaires. The number of fixtures shall be selected based on an illumination level of 70 lux for the staircase and platform. Fixture and control gear shall conform to degree of protection IP55 (min.). At least two (2) fixtures on each platform level shall be fed from aviation warning lighting board (emergency source). All staircase lights shall also be fed from emergency system. Necessary junction boxes with MCBs shall be provided on each platform to control the platform and staircase lights. One (1) 15A, 240V, single phase industrial, weatherproof type, suitable for wall/ column mounting, 3-pin receptacle (Best & Crompton make or equivalent) with suitable interlock shall be provided on each internal and external platforms. At least two 63A, 415V, three phase industrial, weatherproof type, 5-pin receptacles shall be provided at the internal platforms. ~~<u>NDCT ELEVATOR MACHINE ROOM</u>~~ ~~Industrial fluorescent luminaries with 2X40W fluorescent lamps with reflector shall be provided for Elevator machine room. The lux level shall be 100 lux. Four (4) numbers of bulk head luminaries with 100 W GLS lamp and wire guard shall be provided in the elevator pit.~~	

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4.5 OTHER AREAS

Distribution & Lighting Boards area

LED type industrial well glass luminaires.

shall be provided in the Distribution & Lighting boards area.
The lux level shall be 150 lux.

5.0 CABLES AND CONDUITS

5.1 Power cables shall have stranded aluminium conductor, 1100 V grade XLPE insulated, extruded PVC inner sheath galvanized steel wire armoured, overall extruded PVC sheath.

Control cables shall have stranded annealed tinned copper conductor, 1100V grade PVC insulation, extruded PVC inner sheath, galvanized steel wire armoured, overall extruded PVC sheath. Minimum size of control cable shall be 2.5 sq. mm copper. The minimum sizes of LT cable to be chosen are as below:

AL - 16 sq.mm

CU - 2.5 sq.mm

Flexible trailing cable shall have annealed tinned copper conductor, EPR insulated, reinforced with nylon cord, cores laid up, HDCSP inner sheathed, cotton taped and HDCSP overall sheathed conforming to IS:9968.

Power, control and trailing cables shall be FRLS type.

Lighting wires shall have stranded copper conductor PVC insulated, 1100 V grade, laid in galvanized G.I. conduits and shall be of following minimum sizes:

- (a) From Lighting panels to junction boxes : IC, 6 Sq.mm
- (b) From junction boxes to lighting fixtures : IC, 2.5 Sq.mm
(Number of wires per lead as required)

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(c) From Lighting panels to receptacles (15A) : IC, 6 Sq.mm (A1) 5.2 Required number of GI pipe conduit of size not less than 32 mm dia shall be provided. Each conduit riser shall run from the lowest embedded pull box to the highest junction box. The lowest pull box shall be located 450mm above grade in the NDCT shell. Pull boxes shall be installed at every 10m intervals vertically. The conduit risers shall run adjacent to the stairs such that the pull boxes become easily accessible from the stairs. 5.3 Each conduit riser shall have one circumferential conduit at each platform level. The circumferential conduit at each level shall be provided with three (3) more junction boxes equally spaced at the locations of the aviation warning lights. Suitable conduits shall also be provided from the junction box to the respective light point. The GI pull boxes and junction boxes shall be of size atleast 150mm x 150mm x 100mm, 3mm thk, preferably embedded in the concrete shell. 5.4 The conduits shall be electrically connected to all circumferential reinforcing rods which are in turn connected to the down conductors. 5.5 Conduit joints and connections shall be made thoroughly watertight and rust proof by application of white lead for embedded portion or red lead for exposed portion. 5.6 Conduits shall be hot dip galvanised conforming to relevant IS. 5.7 Conduit system shall be electrically bonded to the grounding system. 6.0 <u>GROUNDING</u> 6.1 The Contractor shall provide a complete grounding system as needed for the RCC NDCT. A ground mat, preferably circular type, of diameter at least five (5) meter more than the NDCT foundation diameter shall be laid. 6.2 The grounding installation work shall conform to the requirements of the Indian Electricity Rules and Code of Practice for Earthing (IS: 3043) as		

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amended up-to-date. Each piece of electrical equipment/ structure shall be bonded to the grounding system at two (2) points min.																		
6.3	The main ground mat shall be of bare MS round bar of atleast 40 mm dia buried in earth at a min. depth of 1000 mm below finished grade level. Earth electrode of size 40 mm dia x 3 M length driven into the ground and connected to the ground grid conductor shall be provided, as required, to bring down the ground resistance.																	
6.4	Riser from the ground grid shall be at least 40 mm dia MS round bar and shall project 300 mm above grade / concrete floor level. All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Above grade 50 mmx6 mm galvanised mild steel (450 g/m² zinc coating min) flats shall be run as main ground conductors securely fixed at intervals not exceeding 1500 mm. One end of the galvanized mild steel flat shall be connected to the MS round bar riser by electric arc welding and the other end to the equipment by welding/ bolting, as necessary, subject to approval of the Owner. All welded portion shall be painted with bituminous paints against possible corrosion.																	
6.5	The NDCT ground mat shall be connected to the power plant (BTG) ground mat by 40 mm dia MS round bar at eight (8) points and at six (6) points with ground grid of other area.																	
6.6	Ground grid resistance of the grounding system shall not be more than one (1) ohm.																	
6.7	The ground conductor sizes for grounding of electrical equipment, lighting fixtures, junction boxes etc. shall be as follows : <table><tr><td>(a)</td><td>Distribution Boards, Lighting</td><td>:</td><td>50 mm x 6 mm GS Flat</td></tr><tr><td></td><td>Panels and motors above 90 kW</td><td></td><td></td></tr><tr><td>(b)</td><td>Motors above 30 kW upto 75 kW</td><td>:</td><td>25 mm x 6 mm GS Flat</td></tr><tr><td>(c)</td><td>Motors above 5 kW upto 30 kW</td><td>:</td><td>25 mm x 3 mm GS Flat</td></tr></table>		(a)	Distribution Boards, Lighting	:	50 mm x 6 mm GS Flat		Panels and motors above 90 kW			(b)	Motors above 30 kW upto 75 kW	:	25 mm x 6 mm GS Flat	(c)	Motors above 5 kW upto 30 kW	:	25 mm x 3 mm GS Flat
(a)	Distribution Boards, Lighting	:	50 mm x 6 mm GS Flat															
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	(d) Motors upto 5 kW : 8 SWG GS wire (e) Lighting Fixtures, junction boxes, : 16 SWG G S. wire conduits, etc.	
7.0	<u>LIGHTNING PROTECTION</u> Lightning protection system shall confirm to the requirements of IS:2309, NFPA Code 78, and relevant national & international codes amended up-to-date. The work is subject to approval of the Owner.	
7.1	<u>AIR TERMINATION ROD</u> The NDCT shall be provided with the flue path. The required number of 204 mm dia., 2000mm long, lead coated copper air termination rod with standard GI dome and spikes on one end and 150mm x 6mm thk. MS plate welded to the other end shall be provided. The complete unit shall be lead covered after fabrication. The lightning conductors shall be securely anchored with atleast two (2) suitably spaced adequate size GI lead covered clamps near the top of the stack. Air termination rods shall be mechanically and electrically connected by the use of pressure type fittings to the cap ring and to a continuous circumferential band. The system shall be able to withstand the wind pressure. The top air termination rod shall not exceed the aviation clearance height.	
7.2	<u>CIRCUMFERENTIAL BAND</u> The circumferential band shall be 75mmx10mm GI lead covered flat fixed to the flue at interval not more than 1.0 m. This shall be mounted with suitable anchors at such a height as to be accessible from the top of platform for maintenance. The anchors shall be embedded in concrete wall of the stack. Further these circumferential bands round the flues shall be interconnected by 75mm x 10mm thk. GI lead covered flat.	
7.3	<u>DOWN CONDUCTORS</u> Minimum four number of 75mm x 10mm GS flat down conductors shall be provided. These shall be not more than 15m apart on the periphery of the	

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stack at the ground level. The down conductor shall be connected to circumferential band at the top portion of the stack and to the grounding system at the bottom. These conductors shall be continuous as far as practicable. Intermediate breaks shall be electrically bonded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable. These conductors shall be embedded in the outer surface of the concrete shell and shall come out of the shell below grade level. Conductors embedded in concrete shall have a minimum cover of 50 mm. Railings and steel in the platforms are to be grounded with 50mm x 6mm thick GS flat conductors which are in turn tied to the down conductors. Railings and steel in platforms, ladder, exposed steel works shall also be bonded to down conductors with 50mm x 6mm GS flat. NDCT ladder shall be electrically connected to the down conductors at top and bottom of the ladder. For this, the two (2) lower pairs of insert supporting the ladder shall be adequately connected to the earthing system and the top laid inserts shall be connected to the circumferential band connecting the down conductors. Each down conductor shall be connected to earthing electrode through test point. Conductor from the earthing electrode to a height of about 300 mm above ground level shall be 40 mm MS round bar and thereafter 75mm x 10mm GS flat run. Each of the above earthing electrode shall be connected to the earthing mat at two points. 7.4 <u>TESTING POINTS</u> Each down conductor shall be provided with a testing point installed in GI box embedded on the outside surface of NDCT at a height of 1.5m from the ground level. Testing point shall consist of 50mm x 6mm thk. GS flat with hot dip galvanised bolts, nuts and washers. Incoming and outgoing portion of down conductor at the test point shall be galvanised. 7.5 <u>CLAMPS, ANCHORS ETC.</u> All connections, clamps, anchors etc. of the lightning protection system shall be made of GI fittings. All joints or any other form of electrical connections, unless otherwise specified, shall be clamped or bolted by high pressure contact to form a connection of adequate current carrying		

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capacity and mechanical strength. Soldered connections will not be permitted. 7.6 <u>VERTICAL AND HORIZONTAL REINFORCING BARS</u> All vertical reinforcing bars at the top and the bottom portion of the NDCT shall be electrically connected to the nearest horizontal reinforcing rods and these rods shall in turn, be connected to the down conductors. At each place where vertical reinforcing rods shall be spliced each of the spliced rods shall be electrically connected to atleast one (1) horizontal reinforcing rod which in turn shall be electrically connected to each of the down conductor. The ohmic resistance of the lightning protection system complete with air termination but without the earth connections, shall be a fraction of an ohm so as to permit heavy current flow easily. 7.7 <u>TEMPORARY LIGHTNING PROTECTION</u> During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two (2) permanent electrical earthing conductors. After top lift of the NDCT shell has been completed, temporary air terminations, which may consist of reinforcing bars, should be installed at the top to serve as temporary protection until the lining and cap are completed and permanent air terminations, conductors etc. are complete. 8.0 <u>TESTS</u> 8.1 <u>ROUTINE TESTS</u> During manufacture and on completion, all electrical equipment to be supplied under the scope of this Contract shall be subjected to routine tests as per applicable Standards. 8.2 <u>ADDITIONAL TESTS ON CABLES</u> To prove the FRLS characteristics and rodent & termite repulsion property of outer sheath, each type of cable shall also be subjected to the following additional type tests at works:		

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(a) Oxygen Index Test This test shall be carried out as per ASTM D 2863 at room temperature (27 deg C). Minimum value of oxygen index shall be 29. (b) Temperature Index Test This test shall be carried out as per ASTM D 2863 for normal atmospheric oxygen (21% by volume). The value of temperature Index shall be 250 Deg. C Minimum. (c) Acid Gas Generation Test During Fire This test shall be carried out as per IEC-754-1. The acid gas generation shall be 20% (maximum) by weight of FRLS cable. (d) Smoke Generation Test Under Fire This test shall be carried out as per ASTM D 2843. The cables shall meet the requirements of light transmission of minimum 40% after the test. The test shall be carried out by extrapolation method beyond temperature at which the material of sheath may start deformation as per BICC handbook chapter-6 on cable in fire. The minimum value of temperature Index shall be 250 Deg. C. (e) Flammability Test This test shall be carried out on finished cable as per the requirement of IEEE-383/74, IEC-332-1 and Swedish standard SS: 424 14 :75 class F3. (f) Anti-Termite And Anti-Rodent Test This test for rodent & termite repulsion property shall be carried out as per approved procedure to note the presence of rodent and termite repelling chemical in PVC compound.		

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8.2.1 Type Tests

Type Tests Certificate on any equipment/materials, if so desired by the owner, shall be furnished. Otherwise the equipment shall have to be type tested free of charge to prove the design.

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SECTION – 7

LIGHTING SYSTEM

CONSULTANT : PROCON ENGINEERS

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ANNEXURE-C	FITTINGS AND ACCESSORIES OF LIGHTING TRANSFORMER

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1.0 SCOPE OF WORK

- 1.1 This scope of work shall cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport F.O.R. site of POWER PLANT INDOOR AND OUTDOOR LIGHTING SYSTEM, complete with all materials and accessories for efficient and trouble-free operation.
- 1.2 The scope of work shall include complete installation, testing, commissioning and putting into successful commercial operation of the Lighting System of Power House, Mill building, Transformer Yard and all areas covered under power plant EPC package. This includes the supply of all labor, tools, implements and supplies.
- 1.3 The major areas to be illuminated under the scope of this package are listed in Annexure-A. The areas listed are however indicative only for the purpose of guidance to the bidder and is subject to change during detail engineering after finalization of plant layouts.

2.0 SCOPE OF SUPPLY

- 2.1 The equipment and materials within the scope of supply shall include but not limited to:
- (a) Lighting Transformer.
 - (b) Lighting fixtures with lamps & accessories & LED type fixtures for main roads, secondary roads & perimeter compound lighting.
 - (c) Lighting panels/boards: Main lighting boards, emergency lighting boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with energy saving system
 - (d) Street light poles, flood lighting tower/poles and high mast.
 - (e) Ceiling fans, pedestal fans, receptacles, switches, switchboards, portable emergency lights, portable 24V supply module including handset maintenance equipment etc.

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(f) Cables, wires, splicing/termination/connection accessories. (g) Conduit and accessories, junction and pull boxes, terminal blocks. (h) Grounding materials and connections. (i) All fittings, supports, brackets, anchors, clamps and connections. (j) Steel for field fabrication of supports and brackets (k) Datasheet and technical leaflets on each of equipments / devices. 3.0 <u>SCOPE OF SERVICE</u> 3.1 Carrying out of detail engineering including detailed design manual calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit routing, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the energy saving system. 3.1.1 Furnishing of all labour (skilled and unskilled), supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware and transport for timely and efficient execution of the contract work. 3.1.2 Preparation of AS-BUILT drawings showing field modifications, if any. 4.0 <u>GENERAL REQUIREMENTS</u> 4.1 <u>CODES AND STANDARDS</u> Major standards, which shall be followed, are listed below. Other applicable Indian standards even if not covered in the listed standard shall be followed. (a) IS-1913 (b) IS-1977		

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(c) IS-10322 (d) IS-8623 (e) IS-6064 (f) IS-8828 (g) IEC-598 (h) IS-13703 (i) IS-13947 (j) IS-1248 (k) IS-2705 (l) IS-4160 (m) IS-2713 (n) IS-800 (o) IS-2026 (p) IS-2099 (q) IS-694 (r) IS-1554 (s) IS-9537 (t) IS-14772 (u) IS-5133		

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5.0	<u>DESIGN CRITERIA</u>	
5.1	<u>DESIGN BASIS</u>	
5.1.1	The system provides lighting and electric power supply for lighting to power plant areas & transformer yard extended upto 400kV switchyard fencing. under the scope of this package. In addition, it also provides lighting to selected areas during plant emergency conditions.	
5.1.2	The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust, fly-ash, oil/water vapours as prevalent in a thermal generating plant.	
5.1.3	The design shall be such as to provide minimum lighting levels as specified for different areas.	
5.1.4	The systems shall be suitable for operation on available power supply having characteristics as given in the Datasheet-A & Annexure.	
5.1.5	All fittings of control room / office shall be energy efficient type.	
5.2	<u>SYSTEM CONCEPT</u>	
	The lighting system shall comprise following sub-systems:-	
5.2.1	Normal A.C. Lighting This will be provided by A.C. lighting fixtures distributed throughout the power plant area and transformer yard extended upto 400kV switchyard fencing. These lights will be ON as long as the station A.C. supply is available. A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards will be fed through respective 1:1 ratio lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V, 3ph, 4W, 50Hz effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20%	

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spare outlets.

NOTE

Modules with lighting fixtures cables accessories for coal bunker area lighting to be kept under the scope of main plant with necessary reflection in transformer sizing calculation.

5.2.2 Emergency A.C. Lighting

- (a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in selected areas of the powerhouse, boiler area, boiler galleries and in some selected areas close to the power house etc for general visibility, safe movements and operation of important auxiliaries.
- (b) The emergency MLDBs (EMLDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50 HZ, effectively grounded.
- (c) At least 25% of the fixtures shall be fed from AC emergency source.

5.2.3 Emergency D.C. Lighting

- (a) This will be provided by D.C. lighting fixtures located strategically in critical operating areas and emergency exits. Emergency DC lighting will be catered by DC emergency lighting distribution (DC ELDB) boards. These DCELDBs will feed the DC emergency lighting fixtures directly and through a numbers of DC emergency lighting panels (DC ELP) located suitably in respective areas.
- (b) The DC Emergency Lighting Distribution Boards will be fed from two power sources, namely
 - (i) Main Lighting Distribution Board (MLDB).
 - (ii) 220V DC distribution boards (DCDB).

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(c) These lights will be ON all the time - normally from station A.C. (d) Supply, but on its failure from station D.C. supply through automatic switching. 5.2.4 Remote Emergency Lighting :- This will be provided in isolated building/area/mobile equipments viz. stackers- Reclaimer where D.C. supply is not available by self-contained battery /automatic charger/inverter/flood light units. These portable emergency light units will be energised automatically on loss of normal A.C. supply. 5.2.5 Street/Area Lighting Time switch and photocell will be used for controlling area lights with provision for manual override and also have the provision of latest Energy Saving Systems. Same arrangement will also be used for controlling, boiler gallery, ESP area, turbine floor (high bay) area illumination. 5.2.6 Receptacles To cater to welding of other low voltage power requirement of the plant 63A TPN welding socket fed from motor control centre/A.C distribution board of respective area shall be provided. For other services 15A, 3pin socket shall be provided. 5.3 <u>RATINGS & REQUIREMENTS</u> 5.3.1 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards. 5.3.2 Switch, fuses, MCCB, miniature circuit breakers (MCB), busbar shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.		

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5.3.3	All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.	
5.3.4	All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.	
5.3.5	Heavy duty XLPE FRLS cables as per cable specification will be used for connections :	
	(a) From main lighting board to area lighting panels.	
	(b) From street/area lighting panel to street light poles. From 415V MCCs to receptacles of 63A and above.	
5.3.6	The lighting system will be supplied from 415 V/415 V $\pm$ 5%, indoor, dry type lighting transformers. However it shall be so chosen to limit the fault level within 9kA.	
5.3.7	Suitable number of Flood Lighting Towers / Lighting Masts with adequate HPSV Flood Light will be provided for necessary outdoor areas as required.	
5.3.8	Lighting of all main streets, approach roads to various buildings shall be included.	
5.3.9	Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.	
5.3.10	All A.C. Normal and Emergency A.C. lighting shall be provided with Energy Saving System.	
5.4	<u>METHOD OF CALCULATION</u>	
5.4.1	Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.	

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5.4.2 5.4.3	The coefficient of utilization shall be considered to take care of Lumen loss due to : (a) Effect of room dimensions. (b) Absorption of light in luminaires. (c) Absorption of light at various room surfaces i.e. ceiling wall etc. (d) Floor cavity, ceiling cavity. (e) Mounting height. Moreover a maintenance factor shall also be considered to account for the fall of illumination due to aging, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows: <table border="1"> <thead> <tr> <th>Sr. No.</th><th>Area</th><th>Maintenance Factor</th></tr> </thead> <tbody> <tr> <td>(a)</td><td>Control Room</td><td>0.75</td></tr> <tr> <td>(b)</td><td>Switchgear/ MCC Room</td><td>0.65</td></tr> <tr> <td>(c)</td><td>General Indoor area</td><td>0.60</td></tr> <tr> <td>(d)</td><td>Dusty Area</td><td>0.55</td></tr> </tbody> </table> Utilization factor: (i) Dusty area such as conveyor galleries / Tunnels, TPS / Crusher House etc. = 50 % ceiling, 30% wall, 10 % floor. (ii) Clear areas such as switchgear room/control room etc. =70 % ceiling, 50 % wall, 10 % floor. (iii) Working plan = a) At conveyor walkway level. b) At Building floor level.		Sr. No.	Area	Maintenance Factor	(a)	Control Room	0.75	(b)	Switchgear/ MCC Room	0.65	(c)	General Indoor area	0.60	(d)	Dusty Area	0.55
Sr. No.	Area	Maintenance Factor															
(a)	Control Room	0.75															
(b)	Switchgear/ MCC Room	0.65															
(c)	General Indoor area	0.60															
(d)	Dusty Area	0.55															

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5.4.4 Lux level to be considered for various areas are as follows:-				
Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
5.4.4.1	Turbine Generator Building			
(a)	General Auxiliary Equipment Areas	100	Industrial Well Glass	70W/150W HPSV / 125 W HPMV Lamp
(b)	Cable Vault	70	Industrial type fluorescent lamp with vitreous enamel reflectors	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
(c)	All Switchgear Room Area	200	Industrial type fluorescent lamp with vitreous enamel reflectors	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
(d)	TG Building Operating Floor	200	Industrial Integral high bay	250 W/400W HPMV lamp
(e)	Main Control Rooms	300	Decorative recessed mounted with mirror optic (Dark Lighter)	T5 2 x 28W FTL
(f)	Battery Rooms	200	Industrial Corrosion proof luminarie.	2 x 40W / 36W FTL.
(g)	Unloading and Maintenance bay	250	Industrial integral high bay	250 W / 400W HPMV lamp
5.4.4.2	Boiler Area			

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Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
(a)	Boiler area and platforms	100	Dust proof/dust Tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
(b)	Coal Bunker and Mill bay area	100	Dust proof / dust tight integral well glass luminaire	1 x 80 W /125 W HPMV lamp
(c)	ESP areas and Platforms	120	Dust proof / dust tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
(d)	ESP Control Room	300	Decorative recessed mounted with mirror optic for clean room areas	2 x 36 W / 40 W FTL.
5.4.4.3	Transformer Yard			
(a)	General	50	General purpose flood light	250 W/400 W HPSV lamp
(b)	Near equipment	10-20	Dust proof / dust tight integral well glass	1 x 70 W HPSV lamp
5.4.4.4	Various Off-Site Buildings			

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Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
(a)	Equipment Room / Switchgear Rooms	250	Industrial type fluorescent lamp with vitreous enamel reflectors up to mounting height of 3.5M or Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M.	T5 fluorescent tube with electronic ballast or tri phosphorous tube. 150 W HPSV or 150 /250W HPMV lamp
(b)	Pump Houses	200	Industrial well glass	70 W HPSV/ 125W HPMV lamp
5.4.4.5	Cooling Water Pump House Area			
(a)	Cooling Tower Area	30	Industrial well glass	LED type industrial well glass luminaires (Refer Note-1 below)
(b)	CW PH	200	Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M	
5.4.4.6	Road & Yard Lighting			
(a)	Main Roads	25	Integral type street Lighting luminaire with aluminium reflector	LED type latest energy saving
(b)	Secondary Roads	10	-do-	-do-
(c)	Perimeter (Compound) Lighting	10	-do-	-do-

Note-1 :

Refer separate Annexure-D enclosed with this Specification for technical details of LED luminaires.

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Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
5.4.4.7	Service Building, Canteen, Annex. Building Etc			
(a)	Main Office /Staff Room	300	Decorative recess mounted mirror optics	T5 type 2 x 28W FTL
(b)	Non-Office /Service Areas	300	Decorative recess / surface mounted / Suspended type mirror optics	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
(c)	Staff Room/ conference room etc-	300	Decorative recess mounting, twin/triple compact fluorescent lamp mirror optics luminaire	2x36W CFL
(d)	Toilet passage	70	Decorative recess mounting, twin compact fluorescent lamp mirror optics luminaire	2x18W CFL
5.4.4.8	General			
(a)	Corridors, Walkways, Staircase, Lockers etc.	70	Industrial type fluorescent lamp with vitreous enamel reflectors	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
(b)	Toilets, Wash Rooms, etc.	70	Commercial channel mounted box type	T5 fluorescent tube with electronic ballast or tri phosphorous tube.

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Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
5.4.4.9	Dc Light Fittings			
(a)	Control Room (with false ceiling)	50	Recess mounted Down lighter	1 x 100 W GLS Lamp
(b)	Other Areas (without false ceiling)	20	Industrial bulk head	1 x 100 W GLS Lamp
5.4.5	DM plant area,			
(a)	Control room	300	Decorative recessed mounted with mirror optic for clean room.	T5 type 2x28W FTL.
(b)	Pump House	200	Industrial well glass.	70W HPSV/125W HPMV lamp.
5.4.6	Chemical House			
(a)	Control room.	300	Decorative recessed mounted with mirror optic for clean room areas.	T5 type 2x28W FTL.
(b)	Equipment rooms and Pump rooms	150	Industrial Corrosion proof luminaire	2x40W/36 FTL.
5.4.7	Ash handling system			
(a)	Ah Pump Houses.	200	Industrial well glass.	70W HPSV/125W HPMV lamp.
(b)	Control room	300	Decorative recessed mounted with mirror optic for clean room areas.	T5 type 2x28W FTL.
5.4.8	Coal Handling plant			

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Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
(a)	Conveyors	70	Dust proof/dust tight integral well glass luminaire	1x80W/125W HPMV Lamp.
(b)	Crusher house, Junction towers	100	Dust proof/dust tight integral well glass luminaire	1x80W/125W HPMV Lamp
(c)	Coal Stock yard	50	Non-integral flood light	250 W/400 W HPSV Lamp
(d)	SWGR Room	200	Industrial type fluorescent lamp with vitreous enamel reflectors	2x40W/36W FTL
(e)	Control Room	300	Decorative recessed mounted with mirror optic for clean room areas	T5 type 2x28W FTL
5.4.9	Fuel oil Tank Area			
(a)	Tank area	50	Non-integral flood light	250W/400 W HPSV Lamp.
(b)	Fuel oil area pump house	200	Flame proof well glass	1x80 W/125W HPMV Lamp.
	NOTE: 1. Medium bay fixtures shall be used where the room height is 8 M. Otherwise high bay fixtures are to be used. 2. Lux level for A.C. Emergency lighting in control room shall be 50 and for other areas 20 lux. 3. Lux level for main road lighting shall be 25 and for secondary road shall be 10 lux			
5.4.10	Voltage drop at the fixture from the MLDB bus shall not exceed 3%.			

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5.4.11	Circuit loading of each lighting Panel shall be done in such a way that almost balanced loading in all the phases i.e. R, Y & B is achieved.	
5.4.12	At least two sub circuits shall be used for illumination of a particular area.	
5.4.13	Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.	
6.0	<u>SPECIFIC REQUIREMENTS - SUPPLY</u>	
6.1	<u>EQUIPMENT AND MATERIAL</u>	
6.1.1	Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings, Datasheet-A and Annexures.	
6.1.2	Equipment and materials furnished shall be complete and operative in all details.	
6.1.3	All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.	
6.1.4	All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.	
6.2	<u>LIGHTING TRANSFORMERS & LIGHTING FIXTURES</u>	
6.2.1	Lighting transformers shall be dry type, indoor type dusty vermin proof having 415 V/415 V $\pm 2 \times 2.5\%$ 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.)The casing of the transformer shall be grounded at least at two (2) points.	
6.2.2	If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.	

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6.2.3	Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.	
6.2.4	Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.	
6.2.5	Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth wire connection.	
6.2.6	High bay fixtures shall have provision for vibration damper to ensure rated lamp life. Cost of each damper shall be separately indicated.	
6.2.7	Fixture shall be furnished complete with lamps and integrally/non integrally or separately mounted control gear & accessories as applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, ignitors etc.	
6.2.8	Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop out connection of PVC wires of following sizes :	
	(a) Lighting fixture	: 2.5 mm ² Copper
	(b) Flood Light fixture	: 2x2.5 mm ² Copper
6.3	<u>LAMPS</u>	
6.3.1	General lighting service (GLS) lamps shall be with clear glass and screwed caps.	
6.3.2	All fluorescent lamp shall be bi-pin rotary type and either cool daylight or white as per annexure. Lamp holder shall be spring loaded, low contact resistance type and shall have resistance to wear.	
6.3.3	Mercury/Sodium vapour lamp shall be colour corrected type with screwed cap.	

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6.3.4	Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.	
6.3.5	CFL and T5 fluorescent tube with electronic ballast or tri-phosphorous tube.	
6.3.6	Latest Energy Saving LED type lighting fixtures/lamps suitable for street light and other non-critical area.	
6.4	<u>BALLAST/ELECTRONIC BALLAST</u>	
6.4.1	Ballasts shall be heavy duty, low loss, polyester-filled type with copper winding.	
6.4.2	Ballast for Mercury/Sodium vapour lamp shall be provided with suitable tapping to set the voltage within range specified.	
6.4.3	Ballasts shall be free from hum. Ballasts, which produce humming sound, shall be replaced, free of cost, by the Contractor.	
6.4.4	In multi-lamp fixture, each lamp shall be provided with individual ballast.	
6.4.5	Ballast windings shall have maximum operating temperature of 120oC without rated temperature rise marking.	
6.4.6	Electronic Ballast shall be suitable for 220 V DC and also 240 V AC.	
6.4.7	Electronic Ballast shall be compact, lightweight, high frequency electronic standard ballast for fluorescent lamps.	
6.4.8	It shall be Flicker-free warm start, ideal for areas with high switching frequency.	
6.4.9	Electronic Ballast shall be of such design that minimum 25% reduction in energy consumption at constant luminous flux compared with conventional gear.	
6.4.10	Electronic Ballast shall not be caused to high harmonic distortion.	

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6.4.11	Electronic Ballast shall provide constant light independent of mains voltage fluctuation.	
6.5	<u>LIGHTING PANEL/DISTRIBUTION BOARDS</u>	
6.5.1	Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated from CRCA sheet steel minimum 2 mm thick, suitable for either wall/column mounting on brackets or floor mounting on channel sills.	
6.5.2	Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP - 54 or better; outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle-housing transformer shall be minimum IP-42.	
6.5.3	Lighting Distribution Boards and Lighting Panels 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.	
6.5.4	Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.	
6.5.5	Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.	
6.5.6	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.	
6.5.7	Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit.	

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6.5.8	The plates shall be of anodized aluminium with inscriptions indelibly etched on it.	
6.5.9	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.	
6.5.10	Incoming and outgoing circuits shall be terminated in suitable terminal blocks.	
6.5.11	In lighting and receptacle panel, 3 – phase and 1-phase MCB should not be mixed.	
6.6	<u>BOARD/PANEL EQUIPMENT</u>	
6.6.1	Each Distribution Board shall consist of one dry type transformer housed in the cubicle voltmeter with selector switch, C.T. Operated ammeter and incoming triple pole MCCB. Outgoing feeder from the Lighting Distribution Board shall have MCCB. Proper discrimination between outgoing MCCB of Lighting Distribution Board and downstream MCCB of Lighting Panel should be ensured.	
6.6.2	Each panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB) as per annexure.	
6.6.3	Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.	
6.6.4	All MCCB shall be single throw, air break, and heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type. Contactors shall be air break electromagnetic type. Push buttons shall be push to actuate type.	
6.6.5	MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.	

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6.6.6	Time switch in street lighting panels shall be clock switch type with ON-OFF time setting facility, which shall ensure respective ON-OFF operation in every 24 Hours cycle. Voltmeter/Ammeter shall be of accuracy class 2.0 or better as per IS:1248. Voltmeter/Ammeter selector switch shall be of reputed make.	
6.7	<u>RECEPTACLES</u>	
6.7.1	Receptacles shall be heavy duty, complete with individual plug and switch as detailed in the annexure.	
6.7.2	The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.	
6.7.3	Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.	
6.7.4	Receptacles shall be of following types:	
	(a) Type RA-5A, 240V, 2 pole, 3 pin type with third pin grounded, suitable for flush mounting in MCC Room, office areas, control rooms, store rooms, cabins etc. The switch shall be of piano-key type, also flush mounted and decorative non-industrial type. (b) Type RB-15A, 240V, 2 pole, 3 pin industrial type with third pin grounded, metal clad with gasket having, 19mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for installation in clean/dusty areas. The receptacles located in switchgear rooms, MCC rooms and control room shall have IP-42 degree of protection and those located in other dusty areas shall have IP-62 degree of protection. These receptacles shall be located at an interval of 50M along length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper. Minimum one (1) no shall be provided in all equipment floor, feeder floor, boiler drum level, TPs Crusher House, Sub- Station, Control Room, Pump	

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House,Transformer Room and at suitable location in all other areas as required. In fuel oil area receptacles will be of flameproof type. (c) Type RC-63A, 415V, 3phase, 4pin Industrial type interlocked plug and switch with earthing contact. Other requirements shall be same as Type RB. Interlocking shall be so selected that the switch can be put to 'ON' position only when all the four (4) pins of the plug are housed with complete alignment. In 'OFF' position of the switch the socket outlet shall be completely dead and outgoing terminals isolated. Welding receptacles shall be connected with each other in loop-in loop-out connection the extent of 4 Nos., located at an interval of 50 M. along the length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper and minimum one (1) no. shall be provided in all equipment floor, TPs, crusher house wagon tippler, pump house, substation buildings & cable spreader room, transformer room, boiler platform etc. Separate distribution board shall be used to feed these welding receptacles coming in TG building and boiler areas. At least one (1) no. shall also be provided in each offsite building and boiler areas. At least one (1) no. shall also be provided in each offsite building, which will be fed from 415V MCC. In hazardous areas these receptacle shall be located in MCC rooms. 6.8 <u>FANS & REGULATORS</u> 6.8.1 The fans shall have three well balanced blades, and shall be reasonably free from noise. Pedestal fans shall also be provided as per Owner's requirement. 6.8.2 Fan motor shall be totally enclosed type with copper winding and class E insulation. 6.8.3 Regulator shall have minimum five steps. Electronic regulator with smooth control is preferred. 6.9 <u>SWITCH & SWITCH BOARD</u> 6.9.1 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick bakelite cover with brass fixing screws.		

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6.9.2	Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.	
6.9.3	Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.	
6.9.4	Flush type receptacles where provided shall be so located that only the plug projects outside.	
6.9.5	Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.	
6.10	<u>LIGHTING POLES & FLOOD LIGHT TOWER</u>	
6.10.1	Street Light Poles	
	(a) Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.	
	(b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).	
6.10.2	Flood Light Tower	
	(a) Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.	
	(b) Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800 and subject to Owner's approval.	
6.10.3	Lighting High Masts	
6.10.3.1	Applicable standards	

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The following shall be Reference Standards for loading of the High Mast:

- (a) IS-875 (Part-III) 1987 : Code and practice for design loads for Structures.
- (b) BSEN 10025/DIN 17100 : Grade of M.S. Plates
- (c) BS-5135/AWS : Welding
- (d) BS.ISO 1461 : Galvanizin
- (e) TR. No. 7200 of ILE : UK Specification for Mast and foundation Structure

6.10.3.2 Structure

Lighting High Mast shall be of continuously tapered polygonal cross section, at least 20 sided, hot dip galvanized and presenting a good and pleasing appearance and shall be based on proven In-Tension design confirming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

6.11 MAINTENANCE EQUIPMENT

- 6.11.1 The Contractor shall supply one (1) no. of wheel mounted adjustable aluminium ladder for the maintenance of street lights.

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6.11.2	For the maintenance of lighting fixtures within the power house, the contractor shall also supply four (4) nos. Free standing adjustable aluminium ladder, adjustable from 5m. to 10m.	
6.12	<u>SPECIAL REQUIREMENT</u>	
6.12.1	All outdoor illumination fixtures, unless it is fed from photo cell/time switch controlled lighting panel, has to be provided with outdoor type local switches. In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied and the wiring & fixing of the same has to be done by the contractor.	
6.13	<u>LIGHTING CABLES & WIRES</u>	
6.13.1	Lighting Cable shall be heavy duty, 1100 Volt grade, multicore stranded aluminium conductor, XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLSH conforming to IS 1554.	
6.13.2	Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :	
	RED for R-Phase	BLACK for Neutral
	YELLOW for Y-Phase	WHITE for + ve D.C.
	BLUE for B-Phase	GREY for - ve D.C.
6.13.3	Wire size shall be as follows :	
	(a) For point wiring beyond lighting panel i.e from lighting Panel to junction box (main run)	10 Sq.mm. Aluminium. Stranded conductor
	(b) From Junction box to lighting fixture	2.5 Sq.mm. Copper.
6.13.4	Stranded conductor.	

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6.14	<u>CONDUITS AND ACCESSORIES</u>	
6.14.1	Conduits shall be rigid steel, hot-dip galvanized, furnished in standard length of 3 metres, threaded at both ends.	
6.14.2	Thickness of conduits up to and including 25 mm dia shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 20 mm.	
6.14.3	Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.	
6.14.4	Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.	
6.14.5	Conduit Wiring for Chimney - Complete C.I. conduits, PVC insulated wires, G.I. grounding conductor, weather proof outdoor junction box and all accessories viz. supports, clamps, junction boxes, etc. to make the installation complete in all respects. Conduit wiring shall be from the lighting fixtures to the junction box located at the bottom of the chimney. - All the obstruction lights shall be uniformly distributed over three single phase circuits. Conduit wiring for lighting installation shall be done with PVC cables drawn through the G.I. conduit of proper size. The GI conduits shall be terminated to a fuse box mounted on the chimney shell, at an accessible height from the ground. The cables shall be 1100/650 V grade, 1/c, 100mm² PVC insulated and sheathed Stranded Aluminium conductor. The conduits shall be clamped at interval not greater than 600 mm. by means of approved type of saddles, clamps, etc securely fixed on the shell/ladder. PVC bush shall be used at either end of the conduit. The minimum size of conduit to be used for the installations shall be 65mm. Pull boxes, at intervals of not more than 10 meters, inspection bends, etc. are to be provided at suitable locations to facilitate laying of wires. 8 SWG G.I. wire shall be run along the conduit for grounding purpose. All conduit accessories and junction boxes shall be hot-dip galvanized	

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and of approved type. Wiring shall be done as per the relevant IS specification. 6.15 <u>JUNCTION BOX</u> 6.15.1 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-55. 6.15.2 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks. 6.15.3 Junction boxes for outdoor use shall be weatherproof IPW-55 and those for hazardous location shall be flame-proof type. 6.15.4 Junction boxes shall have following indelible markings : (a) Circuit nos. on top (b) Circuit nos. with ferrules (inside) as per drawing (c) DANGER sign in case of 415V circuit 6.15.5 Junction Box for Chimney The junction box at the chimney bottom shall be weather proof and suitable for flue laden atmosphere and provided with suitable terminal blocks and conduit knockouts for incoming cables and outgoing conduits. Double compression type cable gland shall be used for incoming cables. 6.15.6 Aviation of chimney (a) Minimum eight nos. High intensity LED type red/white flashing type aviation obstruction light as per ICAO and Director General of civil aviation requirements and with corrosion resistant aluminium casting finished in stove enameled control gear suitable for 200/240V, 50 Hz supply, complete as per specification shall be provided. The life of AOLs shall be more than 10 years and with all the necessary fixing accessories as directed by Engineer-in-charge. The AOL system shall be provided with Photoelectric light detectors to monitor north sky for controlling the aviation warning lights.		

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The lights should be switched on when the ambient light goes below 35 candelas and switched off when the intensity is more than 58 candelas. The lights should not be switched off due to momentary increases in light intensities due to lighting flashes or any other short bursts of light. The detectors should be complete with all the accessories, hardware etc. necessary for installation. The facility for Auto/ Manual operation shall be provided. (b) All cables shall be heavy-duty PVC insulated GI wire / flat armoured, PVC sheathed, 650/1100 V grade FRLS copper cable as per IS: 1554 Part-I with owner's approval. The cable shall be clamped at every 750 mm along its run and will include all the hard ware required for its fixing and terminations etc. The Junction/Terminal boxes should be provided wherever required. The cable schedule shall be as under. 4C x10 sq.mm Copper cable for aviation warning lights 4Cx 6 sq.mm Copper cable for power receptacles, stair case lighting and tail end aviation warning lights etc. 2Cx2.5 Sq. mm copper cable for local connection from local Junction box to aviation warning lights. (c) The contractor shall also provided 240V x 15A single phase 3 pin outdoor, weather proof, industrial type switch- socket outlets with inter-lock switches and fitted with metal cap. Required nos. of weather & dust proof (IP-55) 200 mm x 150mm x 100mm deep junction box (2/3/4 way) made out of 2mm thick G.S. with ELMEX type terminals, glands etc. Complete shall also be provided. (d) A lighting Distribution Board and Control Panel for Aviation Warning Lights fabricated from 2 mm thk sheet steel, dust and vermin proof and removable gland plates at top and bottom with ELMEX type connectors and with suitable earthing including 2 nos. 32A TPN incomers, HRC fuses and 2 nos. 32A outgoing connections with HRC fuses and Common Flasher shall be provided. Two inputs will be provided by the bidder along with cable etc.- one the main supply and the other as stand by. Automatic change over with suitable delay timers with Auto/Manual operation shall be provided by the contractor.		

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(e) To care of ICAO and DGCA requirements, the contractor shall provide Temporary Aviation Warning Lights during construction above the 50 m level from general ground level. 6.15.7 Aviation of NDCT “In accordance with ICAO regulations, aviation warning lights are to be installed along the perimeter of the NDCT opening. Operating and reserve aviation warning lights are to be positioned next to each other. They are to be connected to completely separate power circuits and to be monitored by relays. Suitable photo- electric sensors, alarm and annunciation systems, etc. shall also be provided along with the required auxiliaries for completing the system in all respects. Two inputs will be provided by the bidder along with cable etc- one the main supply and the other as stand by Automatic change over with suitable delay timers with Auto / manual operation shall be provided by the contractor. 6.16 <u>TERMINALS</u> 6.16.1 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires. 6.16.2 Each terminal shall be suitable for connection up to 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors. 6.17 <u>PORTABLE EMERGENCY LIGHTING UNIT</u> The portable emergency lighting unit shall be complete with 6volt storage battery (rechargeable), inverter, automatic charger, twin 6 watts fluorescents tube lamp and test switch. Contractor shall furnish make, type and catalogue. 6.18 <u>24 V SUPPLY MODULE</u> Each 24V A.C. supply module shall have one (1) no air cooled two winding, 500VA, 1-phase, 50HZ, 240/24V transformer with 6A (240V side) and		

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16A (24V side) HRC fuse and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 6A, 24V AC receptacles located near Boiler access doors and condenser area shall be wired up from 24V side of each 24V A.C. supply module. The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. Supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure. 6.18.1 Minimum 15 nos. portable 24 V AC supply modules having sheet steel enclosure with louvers as per above shall be supplied for all the three units 24V halogen automobiles lamps with reflector along with 1100 V, twin core PVC sheathed, 2.5 mm² stranded copper wire of 20 m lengths as handset . Exact requirement will be finalized during detail engineering and accordingly the bidder shall furnish the same. 6.19 <u>NAMEPLATE</u> Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to clearly indicate their functions. All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers. 6.20 <u>SAMPLES</u> Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation. 6.21 <u>ENERGY SAVING SYSTEM</u> 6.21.1 Panels The energy saving system panel shall consists of loss less reactance coils with voltage tapping, contactor to select the tap, Micro-processor based		

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TIMER along with real time clock for activating the contactor at a pre-set time. The unit shall be programmable so that at a pre-set time contactor on the lower voltage tap can be selected and reduced voltage can be applied across the circuit. It shall also be possible to modify the setting at site, if required. The capacity of panels shall be 25/30 kVA or more as required. This system shall be incorporated in normal AC panels and Emergency AC panels. 6.21.2 Lamps CFL and T5 fluorescent tube with electronic ballast or tri- phosphorous tube. 7.0 <u>SPECIFIC REQUIREMENTS-SERVICES</u> 7.1 <u>CONSUMABLES AND HARDWARE.</u> 7.1.1 The Contractor shall furnish all erection materials, hardware and consumables required for the complete installation. 7.1.2 The materials shall include but shall not be limited to the following : (a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc (b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc (c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc. 7.1.3 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.		

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7.2	<u>TESTING EQUIPMENT</u>	
7.2.1	The Contractor will provide such checking and testing equipment as test lamp, buzzer, 500-volt megger, earth megger, lux-meter etc. and also other testing equipment as required.	
7.3	<u>INSTALLATION - GENERAL</u>	
7.3.1	Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.	
7.3.2	Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.	
7.4	<u>LIGHTING FIXTURES</u>	
7.4.1	Continuous rows of fluorescent tubes shall be mounted on a continuous M.S. angle for each row of lights.	
7.4.2	In turbine hall, fixtures shall be mounted to maintain sufficient clearance from the overhead travelling crane trolley.	
7.4.3	In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.	
	Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity. If a roof over platform is available, the fixture can be pendant mounted.	
7.4.4	Floodlights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture about 5° on both sides. Bolts shall be finally tightened with spring washer.	
	The Contractor shall supply and install the steel base for fixing the flood	

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light on the flood light towers. Terminal connection to the floodlight shall be made through PVC coated flexible metallic conduits. 7.4.5 Fixtures shall be mounted on sub-station structures with suitable clamps. No cutting or drilling of sub-station structures is permitted. 7.4.6 The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit. 7.5 <u>RECEPTACLES</u> Receptacles shall be installed at locations shown in approved drawings. 7.6 <u>MLDB, EMLDB, DCELDB and Lighting Panel</u> MLDB, EMLDB DCELDB and Lighting panels shall be erected at the locations indicated in approved drawings. 7.7 <u>STREET LIGHTING POLES</u> Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor. 7.8 <u>CONDUIT SYSTEM</u> 7.8.1 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc. 7.8.2 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance. 7.8.3 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.		

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7.8.4	Conduits shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be fixed to the building steel by welding and to concrete or brick work by grouting as shown on drawings.	
7.8.5	Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.	
7.8.6	Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.	
7.8.7	Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.	
7.8.8	Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.	
7.8.9	For directly embedding in soil, the conduits shall be coated with an asphalt - base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.	
7.8.10	Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.	
7.8.11	Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.	
7.8.12	Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.	
7.8.13	Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.	

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7.8.14	For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.	
7.8.15	Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.	
7.8.16	Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.	
7.8.17	Conduit joints and connections shall be made thoroughly water-tight and rust-proof by application of a thread compound which will not insulate the joints.	
7.8.18	White lead is suitable for application on embedded conduit and red lead for exposed conduit.	
7.8.19	The Battery Room installation shall be made with acid fume proof conduits.	
7.8.20	Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.	
7.8.21	The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.	
7.8.22	Lighting fixture shall not be suspended directly from junction box in the main conduit run.	
7.8.23	Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.	
7.8.24	After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.	
7.8.25	In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.	

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7.9	<u>WIRING</u>	
7.9.1	Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.	
7.9.2	Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.	
7.9.3	Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.	
7.9.4	For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.	
7.9.5	For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.	
7.9.6	A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.	
7.9.7	Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.	
7.9.8	Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.	
7.10	<u>CABLING</u>	
7.10.1	In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the over ground portion.	

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7.10.2	Buried cables shall be laid and covered with sand/ riddled earth, and protected from damage by bricks at sides and pre cast concrete slab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.	
7.10.3	When buried cables cross road/railway track, additional protection to be provided in form of hume / G.I. pipe.	
7.11	<u>GROUNDING</u>	
7.11.1	All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules. Ground connections shall be made from nearest available station ground grid. All connections to ground grid shall be done by arc welding.	
7.11.2	Panels/Boards shall be directly connected to ground grid by two nos. 35 x 6 mm G.S. flats. (for panels)/two nos. 50x6 mm G.S. flats (for distribution boards).	
7.11.3	All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 16 SWG G.S. wire.	
7.11.4	Each street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.S flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GS wire. One 16 SWG G.S wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.	
7.12	<u>FOUNDATION & CIVIL WORKS</u>	
7.12.1	Equipment foundations, panel foundations and all other civil work will be provided by the Contractor.	

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7.13	<u>EXCAVATION AND BACK FILLING</u>	
7.13.1	The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.	
7.13.2	Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.	
7.13.3	The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.	
7.13.4	All excavation shall be backfilled to the original level with good consolidation.	
7.14	<u>STEEL FABRICATION</u>	
7.14.1	All supports, hangers & brackets shall be fabricated by the Contractor. Necessary steel shall be supplied by the Contractor.	
7.14.2	Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.	
7.14.3	Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated.	
7.15	<u>PAINTING</u>	
7.15.1	Street light poles shall be given two coats of aluminium paints after installation.	
7.15.2	All steel fabrication shall be given two coats of redoxide primer followed by two coats of battleship Siemens gray RAL-7032.	
7.15.3	All equipment shall be given touch-up paint as required after installation.	

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7.16	<u>INSPECTION & TESTING</u>	
7.16.1	On completion of erection works, the Contractor shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.	
7.16.2	The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.	
7.16.3	The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.	
7.16.4	All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.	
8.0	<u>TESTS</u>	
8.1	<u>SHOP TESTS</u>	
8.1.1	All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.	
8.1.2	Tests on lighting Distribution Boards/Panels shall include :	
	(a) Wiring continuity tests.	
	(b) High voltage and insulation tests.	
	(c) Operational tests.	
8.2	<u>SITE TESTS</u>	
8.2.1	Contractor shall thoroughly test and meggar all cables, wires and equipment to prove that the same are free from ground and short circuit.	
8.2.2	If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.	

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8.2.3	All equipment shall be demonstrated to operate in accordance with the requirements of this specification.	
8.2.4	Illumination in different areas are as per designed lux level should be established to the satisfaction of the Owner.	
8.3	<u>TEST CERTIFICATES</u>	
8.3.1	Certified copies of all tests carried out at works and at site shall be furnished in requisite no. of copies for approval of the Owner.	
8.3.2	The equipment shall be dispatched from works only after receipt of Owner's written approval of shop test reports.	
8.3.3	Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.	

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<u>LIGHTING & LIGHTING TRANSFORMER</u> <u>DATA SHEET – A</u>			
<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
1.0	<u>AUXILIARY POWER SUPPLY</u>		
1.1	<u>SYSTEM VOLTAGE</u>		
	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, 50 Hz, 3 wire effectively grounded system Fault Level 50 kA R.M.S. symmetrical
1.1.2	D.C. Supply		Fault Level 25 kA symmetrical 220 V, 2 wire, ungrounded system.
1.2	<u>PERMISSIBLE VARIATION</u>		
	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 + Frequency $\pm 10\%$ (absolute sum).
1.2.2	D.C. Supply		Voltage 198 to 242 Volt
2.0	<u>LIGHTING TRANSFORMER</u>		
2.1	Type		Cast Resin Dry Type

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
2.2	kVA rating		100 kVA
2.3	Voltage rating		415 V/415 V
2.4	Cooling		AN
2.5	P.U. Impedance		0.04 ±10%
2.6	Voltage control		Off load tap switch/link with change of ±5% in step of 2.5% tapping full capacity
2.7	Vector Group		Dyn11
2.8	Class of Insulation		F (155°C)
2.9	Maximum Temperature rise over 50°C. ambient in winding by resistance		90°C
2.10	Neutral		Solidly grounded.
Notes: - The secondary neutral of the transformer shall be brought out for getting a grounded 4wire 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. - DC fault level indicated in Sr. No. 1.1.2 above is Indicative only, actual value will be decided by the Bidder after substantiating the same by calculation			

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
	5. Typical Transformer rating of 100 kVA is indicated in Datasheet-A Sr. No. 2.1. However rating of transformer required shall be worked out by the bidder. Calculation for the same shall be submitted with Bid.		

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ANNEXURE – A

BROAD LIST OF AREAS TO BE ILLUMINED

- 1.0 Purpose of this list is to give general guidance on major areas to be illuminated. The list is however not exhaustive. Scope of lighting shall cover power house area, railway track, pump houses, different buildings, rooms, crusher house, tanks, transformer area and adjacent area/street, open yards, peripheral road inside boundary wall etc. The responsibility for provision of illumination of all the areas shall lie with the power plant EPC Contractor. Illumination engineering shall be done by the power Plant EPC Contractor based on the detail layout developed for rooms/areas during detail engineering and considering the guidance provided in Lighting Notes & Details.
- (a) Power House Building.
 - (b) Transformer Yard for GT, ST & UT extended upto 400kV switchyard.
 - (c) Boiler Area for Units, Boiler galleries, platforms, stairs.
 - (d) E S P
 - (e) E.S.P Control Building.
 - (f) Service Building (Centralized Control Rooms)
 - (g) C.W and ACW Pump House.
 - (h) C.W. Chlorination Plant Building.
 - (i) Mill Bay.
 - (j) All roads in the transformer yard including approach roads (as will be finalized during detail engineering), general area, Toilets falling within lighting zone shall be covered under power plant EPC package.

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(k) Chimney along with aviation lighting (l) NDCT along with aviation lighting (m) DG & Compressor BLDG. (n) Ash Water P.H. & Elec. Room. (o) ASW pump house & Elec. Room (p) Chemical house/Electrical and control room (q) HFO & LDO pressurizing pump house (r) Fly ash conveying Comp. BLDG. & Elec. Room (s) Open yard (t) Store (u) Canteen (v) Work shop (w) Weight bridge (x) DM plant (y) Wagon tippler (z) Wagon tippler Control Room along with Railway track. (aa) Pent house (bb) Crusher house (cc) CHP MCC and Control room (dd) Fuel oil transfer pump house along with Railway track		

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(ee) HCSD pump house and MCC room (ff) Dry ash silo and HCSS silo (gg) MCC cum ctrl. Room of HCSD system (hh) Lube oil storage shed (ii) ETP (jj) In plant raw water reservoir & PH. (kk) Fire station (ll) Pretreatment & filtration plant (mm) TTW & FW pump house (nn) Plant area STP (oo) Administration building (pp) Check post (qq) Secondary gate (rr) Ash gate (ss) CW treatment BLDG. (tt) Loco shed (uu) Peripheral road inside boundary wall (vv) Security office (ww) Any other as per plot plan & relevant drawings.		

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ANNEXURE – B

TYPES & BOM OF LIGHTING FIXTURES & LAMPS

Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.0		<u>LIGHTING LUMINARIES</u>				
1.1	A	Industrial bulkhead luminaire, suitable with 1x GLS 100 W incandescent lamp. The luminaire should comprise of single piece pressure die cast aluminium housing and cover retaining frame made of LM6. The housing should be stove enameled white inside. The luminaries should have heat resistant toughened frosted glass cover along with a gasket made of EPR to ensure insect free satisfactory performance without ingress of water. A powder coated m.s. wire guard and all other accessories suitable for ceiling/wall mounting. (For use in inside area) Similar to Bajaj BJDB 100/Philips NXC 101 or equivalent.	1x100 W GSI 240V AC 220V DC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.2	B	Well glass luminaire, dust proof & rain proof, light weight pressure die cast aluminium housing LM6 painted gray outside and white inside, with porcelain lamp holder (E-27) along with an earthing terminal heat resistant toughened clear glass cover with gasket made of EPR, pressure die cast Al. (LM6) ring hinge to the housing, powder coated m.s. wire guard mounting provision suitable for suspension by means of dia. 20 mm threaded GI pipe. The fixture should conform to degree of protection IP-65 (min) Similar to Bajaj BJVW 200/Philips NDC 203 or equivalent.	1x100 W GSI 240 V AC 220 V DC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.3	C	Recessed downlight luminaire with asymmetric beam suitable for use in non-ventilated false ceiling. The luminaire should comprise sealing ring made of aluminium, pressure die cast. The frame with adjustable mounting clamps should be made of m.s. and zinc plated. The reflector should of high purity aluminium sheet electrochemically brightened and anodized. The luminaire should have E27 porcelain lamp holder fixed to nylon connector system pre-wired up to terminal block. The mounting clamps should be such so as to be adjusted according to the ceiling thickness for easy installation for different ceilings. Similar to Philips DN 622/ Bajaj BJDR 100 or equivalent.	1x100 W Comptalu x 240 V AC 220 V Dc			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.4	D	Surface/pendant mounted 2X 28 W, channel with aluminium reflectors, luminaire body shall be of high quality aluminium which is anode oxidized, parabolic reflector with extruded aluminium, fire retardant ABS end caps. Luminaire shall be wired with electronic ballast. The accessories shall be prewired up to the terminal box. The luminaire should be suitable for wall / ceiling mounting by means of suspension conduits of 20 mm and also suitable for cantilever type bracket mounting. Degree of protection-IP 20 (min) Bajaj type BTIA 228 or equivalent.	2x28 W (228) Fluorescent (T 5 lamp) 240 V AC			
1.5	E	CRCA sheet body finished in white powder coating with Aluminum reflector for better reflectivity and perforated mirror optics for smooth glare free lighting. Luminaire shall be complete with ballast, starter and all accessories wired up to terminal block, suitable for 1X28 tube lamp.	1x28 T5			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.6	F	Corrosion proof luminaire : Control gear housing of cast aluminium epoxy primer above enameled grey incorporating ballast, capacitor, terminal block to seamless aluminium pipes carrying the connecting leads end boxes made of cast aluminium fixed at the end of seamless pipe to accommodate starter holders starters and specially designed vapor proof lamp holders. Degree of protection –IP-51 (min) Similar to Bajaj BJI 236 VP/Philips TMX 92(236) or equivalent.	2x36W Fluorescent 240V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.7	G	Indoor recessed mounting luminaire housing made of CRCA sheet stove enameled white inside and out incorporating accessories such as slim open construction low watt loss, click fix lamp holders all wired up to terminal block. A specially designed decorative and efficient system of vacuum metalised polystyrene prismatic louvers (similar to pattern 12 of scientific lighting product) to achieve glare free and pleasant lighting without loss of light output. The max. Height of luminaire should not exceed 90mm. the luminaire shall be square shaped with dimensions of approx. 475X475 mm outer Similar to Bajaj BMLA 01 336 CFL or equivalent.	3x36W CFL 240 V AC			
1.8	H	Similar to 1.7 (a) above but with electronic ballast.	3x36 CFL: 240 V AC			

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Sr. No.	Type	Particulars	Wattage/m ains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.9	I	Flame proof luminaire : Well glass non-integral flame proof fixture die cast aluminium LM 6 housing enamel heat resistant toughened well glass, with hot dip galvanized wire guard a spigotted terminal cum lamp holder plate made of LM6 with an E 27 type porcelain lamp holder 1X19mm BSC/ET cable entry with an option ceiling/wall mounting or suspension with a bracket or an eye bolt Separate flame proof control gear enclosure of die cast aluminium housing with cover, chain suspension for the cover assembled with all accessories and loop in loop out arrangement. All termination within the control gearbox should be suitable for explosive environment. The fixture & control gear should be suitable for use in hazardous area zone-1& zone- 2 as per IS 5572(part I)-1978 and for explosive environment of gas Group-IIA & II B as per IS 2148-1981. Degree of protection IP55 Similar to BAJAS'S-BJFW-80/125MV/Philips NGD26 (125) and CGE 125 or equivalent.	1x125W HPMV 240 V AC			
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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.10	J	Well glass luminaire, dust and jet proof, light weight housing made of corrosion resistant die cast aluminium alloy in conjunction with separate control gearbox. Housing should be stove enameled gray outside white inside after application of epoxy base primer, a porcelain lamp holder (E-40 type) prewired up to terminal block located inside the housing along with earthing arrangement. The luminaire should be suitable for suspension by means of threaded G.I. Pipe of 20 mm bore and also for 'j' bracket mounting. A glass cover made of heat resistant glass (annealed) provided with EPR gasket encased in die cast aluminium ring hinged to the housing. Should have external vitreous enameled reflector. Degree of protection-IP 55 (min) for luminaire and IP 54 (min) for control gear. Similar to Bajaj BJVW 300/Philips NDC 21(150) or equivalent.	1x150W HPSV 240 V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.11	K	Well glass luminaire, similar to above but suit able for 70 W HPSV lamps. Luminaire shall have external M.S. sheet steel vitreous enameled reflector with integral control gear, degree of protection IP 65 (Minimum)	1x70W HPSV 240 V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.12	L	High bay luminaire industrial closed version luminaire with painted die cast aluminium housing accommodating vibration proof E-40 lamp holder with a provision for adjustment to obtain narrow / wide beam distribution, painted die cast aluminium mounting tray accommodation ballast, capacitor and igniter all pre wired up to the terminal block, a chain to suspend the housing, a cable entry gland or grommet for entry of incoming cable and an internal earthing. An anodized spun aluminium spacer between housing and reflector and high purity/a glass reflector electro-chemically brightened and anodized flat toughened glass fixed to the reflector by toggle to suspend the glass cover, an eye bolt of Zinc plated and passivated M.S. Degree of protection IP-52 (min) Similar to the Baja BGEHB 250 SV/TE/Philips SDK 103(250) or	1x250 W HPSV 240 V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.13	M	Medium bay luminaire- similar to HB above expect suitable for lower mounting height with 150 W HPSV lamps. Similar to Bajaj BGEGB 150 SV/Philips SDK 104 (150) or equivalent.	1x150W 240 V AC			
1.14	N	Escape lighting luminaire with "EXIT" sign type i.e. EXIT sign always visible fitted with 1x20 fluorescent tube. Each luminaire shall be self contained 6 volt battery, battery charger unit. Normally the luminaire shall be ON continuously through 240 V AC supply. When AC supply goes OFF the in built battery & inverter system automatically takes on to ignite luminaire for duration of two and half (2 1/2) hours. The battery shall be maintenance free and shall be trickle charged when 240 V AC mains supply is available.	1x120W 240 V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.15	O	Street light luminaire-weather proof having housing made of corrosion resistant LM6 die cast aluminium epoxy powder coated in an attractive grey colour out side. Specially developed pot mirror optimized for use with tubular lamp of high purity aluminium, electrochemically brightened and anodized, copper etc. accommodated in gear compartment of housing. Long life neoprene gasket, to avoid entry of insects, cover made of acrylic. Degree of protection-IP-43 suitable for 150 SV lamps. Similar to Bajaj BGEST SV/Philips SRP 501(501) or equivalent.	1x150W HPSV 240 V AC			

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
1.16	P	Indoor mirror optics recessed mounting luminaire housing made of CRCA sheet powder coated white inside and out incorporating accessories such as slim open construction low watt loss, click fix lamp holders all wired up to terminal block. A specially designed decorative and efficient optical system of opal transverse ABS plastic fins with chrome plating to achieve dark light characteristic without loss of light output. The max. Height of the luminaire should not exceed 120 mm. The luminaire should be suitable for mounting in standard modular strip ceiling (Luxlon 84R) Similar to Bajaj BJPM 236/Philips TBS 82(236) or equivalent.	2x36W Fluorescent 240V AC			
2.0		<u>LIGHTING BOARD/PANEL</u>				
2.1	MLDB & EMLDB	415V A.C. Indoor type Lighting distribution board with transformer , 415 V, 200A, 3 ph, 4 wire bus, one 200A triple pole switch as incomer, 8 Nos. 100A, TP & N switch and fuse as outgoing feeders.				

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
2.2	DC ELDB	Indoor type Emergency Lighting Distribution Board with 100A, 415 V TPN bus, 1 no. 100A TP & N switch fuse as A.C. incomer, 1 no. 100A D.P. switch fuse as D.C. incomer and 18 nos. 20A, 2 pole MCB with back-up fuse as outgoing feeders complete with auto change over control circuit, push button, indication lamp, etc. with provision for manual override & test facility to test all emergency circuit.				
2.3	LP-1	415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch as incomer, 18 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.				
2.4	LP-2	415 V A.C. Indoor Lighting panel with 415 V, 3ph, 4W bus & one 63A TP & N Switch as incomer and 12 nos 20A , 240V 1 pole MCBs as outgoing feeder.				

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
2.5	LP-3	415V A.C. Indoor type Lighting Panel with 415 V, 63 A, 3 ph, 4 wire bus, one (1) no. 32 A TP & N switch as incomer, 6 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.				
2.6	SLP	415V A.C. Outdoor type Panel with 415 V, 100A, 3 ph, 4 wire bus, one 100A TP & N switch as incomer, 18 nos. 20A, 240V, 1 pole MCBs as outgoing feeders The lighting panel shall be provided with 63A contactor, frequency compensated timer switch, photo-cell switch push- buttons for automatic control of street/area lighting with provision for manual override				
2.7	DCEL P	Indoor type emergency lighting panel with 240V bus, one no 20A switch fuse as incomer and 6 nos 16A two pole MCB with back up fuse as outgoing feeders				
2.8	FLP	Outdoor, lookable type Isolating switch of 415V, 32A, 3 ph, 4 wire TP & N. with 2 mm sheet steel/cast iron cubicle				

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
3.0		<u>RECEPTACLE</u>				
3.1	RA	6A, 240 V, 2 pole, 3 pin with third pin earthed, suitable for flush mounting in office areas and control room. the switch shall be also flush mounted piano type				
3.2	RB	16A, 240 V, 2 pole, 3 pin with third pin earthed, wall/column mounted, metal clad gasketed construction, 20mm conduit entry, screwed metal cover tied to it by a metal chain, weatherproof suitable for indoor / outdoor installation				
3.3	RC	63A, 415 V, 3 phase, 4 pin interlocked plug and switch with earthing contact, wall/column mounted, metal clad gasketed construction, weatherproof, suitable for loop-in/loop-out connection of 4/C-35 Sq.mm XLPE cable. These shall be fed from AC Distribution Board/Station MCC				

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
3.4	RD	125 A, 415 V, 3 phase 5 pin interlocked plug & switch with fifth pin earthed, wall/column mounted metal clad gasketed construction, weatherproof, suitable for loop in and loop out connection of 3-1/2C -95 Sq.mm XLPE cable. These shall be fed from A.C-Distribution Board/Station MCC				
4.0		<u>CEILING FANS</u>				
4.1	FA	1200 mm sweep ceiling fan with regulator, down rod and canopy				
	FB	1400 mm sweep ceiling fan with regulator, down rod and Canopy				
5.0		<u>LIGHTING POLES</u>				
5.1	TA/TB	Single arm/double arm swaged and welded steel pole with junction box and all accessories				
6.0		<u>SWITCHBOARD</u>				
6.1	S1	Switch board with 1-5A switch.				
6.2	S-2	Switch board with 3-5A switch and 1-5A receptacle				

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Sr. No.	Type	Particulars	Wattage/mains Voltage	Qty.	Unit Rate (Rs.)	Total Cost (Rs.)
6.3	S-3	Switch board with 6-5A switch and 1-5A receptacle				
7.0		<u>MISCELLANEOUS ITEMS</u>				
7.1	M1	10 m high car wheel mounted aluminium ladder				
7.2	M2	Adjustable free-standing aluminium ladder height adjustable from 5 m to 10 m				
7.3	M3	Portable Emergency light set complete with one 20W tube light, battery, battery charger and all other accessories.				
7.4	M4	24 Volt Supply Module with all accessories				
<u>Notes:</u> - Each lighting fixture shall be furnished complete with associated lamp, holder and control gear fully wired up. Control should include copper ballast, copper choke, capacitor starter, electronic-igniter (separate type), fuse connector block etc. - For well glass fittings for HPSV lamps higher wattage (250/400 W) floodlight luminaire, the control gear will be separate/non-integral type whereas for high bay, streetlight and mini flood light fixture, the control gear shall be integral type. - Make, type & catalogue no. of lighting fixtures are indicated herein with the intent to elaborate the physical appearance / constructional features only pertaining to the particular type of fixture - The supply also includes associated junction boxes, brackets, supports, hangers, and wires wherever applicable						

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LIGHTING & LIGHTING TRANSFORMER

ANNEXURE – C

FITTINGS AND ACCESSORIES OF LIGHTING TRANSFORMER

1.0 EACH TRANSFORMER SHALL BE EQUIPPED WITH FITTINGS AND ACCESSORIES AS LISTED BELOW:

- (a) 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.
- (b) Handling and lifting lugs both for enclosure and core-coil assembly.
- (c) Jacking pad for core-coil assembly.
- (d) Inspections cover for cable and box.
- (e) Door handle operated safety limit switch with 1NO + 1NC contact.
- (f) Ground bus.
- (g) IP-55 junction box.
- (h) 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.

Annexure-D : LED LIGHTING SPECIFICATION

TECHNICAL SPECIFICATION FOR LED LIGHTING

- The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 80 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be “cool day light” (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. LED shall conform to the LM 80 requirements.
- The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire. The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.
- Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and water proof protection as per IS 12063.

Driver Circuit

LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer. LED Drivers shall have following control & protections:-

- Suitable precision current control of LED.
- Open Circuit Protection
- Short Circuit Protection
- Over Temperature Protection
- Overload Protection
- Surge Protection

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VOLUME IV-A

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415 V PCC / PMCC / MCC, 415 V AC &

220 V DC DB/SVB/FB, 220V DC STARTER

AND 415V NON-SEGREGATED PHASE BUSDUCT

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<u>CLAUSE NO.</u>	<u>DESCRIPTION</u>

11.0	TEST WITNESS

DATA SHEET - A	415V LT SWITCHBOARD

DATASHEET - A	415V NON SEGREGATED BUSDUCT

ANNEXURE-A	LIST OF PMCC/PCC/MCC/DBs/SVBs/FBs/DC STARTERS

ANNEXURE-B	MODULE SELECTION

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(A) 1.0 1.1	<u>415V PCC/PMCC/MCC, 415V AC & 220V DC DB/SVB/FB, 220V DC STARTER</u> <u>SCOPE OF SUPPLY</u> The following equipment shall be furnished complete with all accessories : (a) 415V Power Control Centres (b) 415V Motor Control Centres (c) 415V Power-cum-Motor Control Centres (d) 415V Distribution Boards and Fuse Boards (e) Solenoid valve boards (f) DC starters (g) 415V Non-segregated phase busduct A list of various 415V boards that have been envisaged to be supplied under the power plant EPC package is given in Annexure - A This list is only for general guidance of the Tenderers and the exact numbers shall be finalised by Bidder During Detail Engineering. Base channel frame of all boards along with necessary mounting hardware. Set of accessories as listed below : (a) Breaker lifting and handling trolley (b) Racking in/out handle for breakers (c) Racking in/out handle for drawout MCC modules Mandatory spares	

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1.5	Rubber mats suitable for 1.1kV grade as per IS 15652-2006 shall be provided in front of switchgear.	
1.6	All relevant drawings, data and instruction manuals.	
1.7	<u>AUTO CHANGEOVER:</u>	
1.7.1	Auto changeover facility shall be provided in PCC and MCC as required, during DDE this switchgear/MCC will normally operate with Buscoupler open. If sustain under voltage it detected on any one of the bus section, the respective incoming breaker shall trip and buscoupler shall close if voltage is available on the other bus section. Auto changeover shall be blocked if the incoming breaker has trip due to bus fault. Manual changeover from one source of supply to other or vice versa shall be possible by momentary paralleling of two supplies after checking synchronism with the help of synchro check relay. On closing incoming breaker, the running breaker should trip within preset time. An annunciation shall be provided if the two-bus section remains parallel for more than preset time. If the running breaker fails to trip within the preset time the incoming breaker shall trip. All necessary voltage/Isolating transformer, synchro check relay etc shall be supplied for this. The momentary parallel schemes shall be applicable for unit and station PCC.	
1.7.2	Emergency switchgear shall have three incomers, one from Unit PCC, which is normally closed and another from Station PCC and one from DG set without any buscoupler. Incase of sustain under voltage on already close incomer, the same will trip and other incomer will close automatically after appreciate time relay. Incase this automatically closed the second incomer also trip due to sustain under voltage, which is normally closed automatic starting signal will be given to DG set. After the voltage built up by DG set.DG set incomer shall close automatically.	
2.0	<u>GENERAL NOTES</u>	
	In the context of the specification, the following definitions shall apply.	

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2.1 **POWER CONTROL CENTER (PCC).**

2.1.1 **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 feeders 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.

2.2 **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.

2.3 **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.

2.4 **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.

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2.5 2.6 3.0 3.1 3.2 3.3	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. 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. AC Fuse Boards shall be with 415V/240V isolation transformer. Incomers and outgoing feeders of DC Fuse Boards shall be 220V, 2-wire type. The 240V supply for HT Panel & Motors Space Heater, wherever required shall be derived through 415V/240V Isolation transformer. <u>CODES AND STANDARDS</u> All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification. Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid. The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.	

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4.0 SYSTEM CONCEPT AND DESIGN CRITERIA

4.1 415V power distribution within the powerhouse shall be by mean of PCCs, MCCs, DBs, SVBs and FBs.

4.2 The PCCs/PMCCs shall be used to supply auxiliary power for normal and start up operation of generation units.

The MCCs/DBs/SVBs/FBs shall be used to provide power, control, and protection for A.C and D.C. auxiliary services (motors and feeders) of generating units.

4.3 The equipment will be located in a hot, humid, and tropical atmosphere, heavily polluted at places with coal dust and/or fly ash.

4.4 Duty involves direct-on-line starting of large induction motors 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 of full load current.

4.5 Busbars of PCCs/PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20% margin.

Busbars of MCCs/DBs/SVBs/FBs shall be sized to carry continuously the total running load of the MCC/DB/SVB/FB with 20% margin.

Loads of outgoing feeders wherever applicable shall also be considered while sizing the busbars, equipment and components thereof. All busbars shall be capable of withstanding the mechanical forces and thermal stresses due to maximum short circuit current.

4.6 Minimum height of motor startor Module shall be 400mm & for SFU 300mm.

4.7 In-cubicle ratings of incomer and bus-section breakers/switches shall be identical to the associated busbar rating.

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4.8	Incomer feeders & outgoing feeders rated up to and including 400A shall be SFU. Above 400 A, all incomers and outgoing feeders shall be breaker (ACB) controlled.	
4.9	All motors rated 90 kW up to and including 160 kW shall be breaker controlled. For motor, rated 75 kW and above shall be provided with Numerical motor protection relay.	
4.10	For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and /or this specification.	
4.11	Circuit breakers shall not produce any harmful over voltage during switching OFF of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.	
4.12	Incomer and Bus-sections of all MCC/PMCCs shall have provisions for remote operation from the respective control room through electrical control desk /CRT monitor.	
4.13	Softwire logics are not acceptable for interlocks. Incomer and Bus coupler interlock shall be through hardwired logic only.	
5.0	<u>SPECIFIC REQUIREMENTS</u>	
5.1	<u>CONSTRUCTION</u>	
5.1.1	PCCs/PMCCs/MCCs/DBs/SVBs/FBs shall be indoor, air insulated, and metal-clad type. The design construction shall be such as to permit extension at either end.	
5.1.2	PCCs/PMCCs/MCCs shall be drawout type. DBs/FBs/SVBs shall be fixed type.	
5.1.3	PCCs/DBs/SVBs shall be of single-front construction and PMCCs / MCCs shall be of double-front construction. Breaker panels of PMCCs shall be of single-front construction.	

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5.1.4	In switchgear room and control room, all PCC/PMCC/MCC/DB/SVB / FB enclosures shall conform to the degree of protection IP-54 for ampere rating upto 1600A and above 1600 A the degree of protection will be IP-42. Minimum thickness of sheet metal used shall be 1.6mm for nonload bearing end and 2mm for load bearing end. The design shall be such that the specified degree of protection is achieved even after a breaker control module has been taken out of the panel. 5.1.5 MCC/DB/SVB assemblies shall comprise of a continuous line-up of dead front, freestanding vertical sections, housing the control modules in multi-tier formation. 5.1.6 PCCs/PMCCs/MCCs/SVBs/DBs shall be fully compartmentalised with metal/ insulating partitions between compartments. FBs shall be non-compartmentalised. Working height shall be limited between 300 mm and 1900 mm above finish floor level including 100 mm base channel height. 5.1.7 Each breaker/control module shall be housed in a separate cubicle, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section shall have a removable back cover. All doors and covers shall be gasketed. 5.1.8 Breaker cubicles shall be so sized as to permit closing of the front access door when the breaker is pulled out to ISOLATED position. The breaker can be operated both in service & test position with the door closed. 5.1.9 For breaker panels, all switches, lamps, and indicating instruments shall be flush mounted on the respective compartment door whereas relays and other auxiliary devices shall be mounted in a separate compartment. For MCC/DB/SVB modules, all push buttons, lamps, and indicating instruments shall be flush mounted on respective module compartment.	

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5.1.10	For single-front assemblies, a full-height vertical cable alley with cable supports shall be provided in each section to facilitate unit wiring. The alley shall be liberally (250mm minimum) sized to accommodate all cables as per cable schedule and shall have removable cover at the front for access.	
5.1.11	A horizontal wire way extending the entire length of the assembly shall be provided at the top for inter-panel wiring.	
5.1.12	Incomers shall be provided at the ends of an assembly and bus section, wherever required, shall be provided at the middle of the assembly.	
5.1.13	Four (4) Nos. lifting lugs shall be for each section, two (2) nos. on either end of the section.	
5.1.14	PCCs/PMCCs/MCCs/DBs/SVBs shall be supplied with base frames of 100mm height of structural steel sections along with all necessary mounting hardware required for bolting/welding the base frames to the foundation. FBs from finished floor level shall be supplied along with necessary hardware for mounting against wall.	
5.1.15	After isolation of power and control circuit connections, it shall be possible 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.	
5.1.16	The minimum clearance in air between phases for the entire run of horizontal and vertical busbars shall be 25mm & between phase and earth shall be 19mm. For all other components, the clearance between two live parts, a live part and an earthed part, and isolating distance shall be at least 10mm through out. Wherever it is not possible to maintain these clearances, insulation shall be provided by barriers. However, for horizontal and vertical busbars, the clearances mentioned above should be maintained even when these are sleeved or insulated. All connections from busbars up to fuses shall be fully shrouded to minimize the risk of phase-to-phase and phase to earth shorts.	

- ### 5.3 MCC/SVB/DB MODULES

- 5.3.1 MCC/SVB modules shall have self-aligning power/control disconnects. All disconnects shall be silver-plated to ensure good contacts.
- 5.3.2 Modules of same size and type shall be physically and electrically interchangeable.
- 5.3.3 The design of drawout modules shall be such as to permit easy withdrawal/re-insertion of the unit with guide rails to ensure correct alignment.
- 5.3.4 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.
- 5.3.5 Drawout modules shall have three distinct positions, namely, SERVICE, TEST and ISOLATED.

In the 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.

In the 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

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of module in closed condition, the Breaker can be placed in ISOLATED, TEST or SERVICE position from outside. In the ISOLATED position, both power and control circuits shall be disengaged. 5.3.6 Modules shall house the control components for a circuit such as switch, fuse, contactors, relays, push buttons, lamps, meters, etc. 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 provide specified IP-54 degree of protection when the module door is closed. 5.3.7 Breaker operated incomers and bus sections shall be provided with one (1) TEST-LOCAL-REMOTE selector switch. Contactor operated motor feeder modules shall be provide with one (1) LOCAL-REMOTE-MCC selector switch. 5.3.8 The component layout shall provide sufficient working space in between the components. 5.4 <u>CIRCUIT BREAKER</u> 5.4.1 Circuit Breakers shall be three pole for motors and four poles for incomer, buscoupler and outgoing feeder, single throw, air break type with stored energy, trip free mechanism and shunt trip coil. 5.4.2 Circuit breakers shall be drawout type, having SERVICE, TEST & ISOLATED positions with positive indication for each position. 5.4.3 Circuit breakers of identical rating shall be physically and electrically interchangeable. 5.4.4 All incomer breakers, bus-section breakers, and motor feeder breakers shall have motor wound spring charging mechanism. 5.4.5 Each breaker operated feeder shall be provided with protective devices as specified in protection system.		

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5.4.6 5.4.7 5.4.8 5.4.9 5.4.10 5.4.11	All breakers with motor wound spring charging mechanism shall have facility of manual spring charging also. 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. 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. Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn. Each breaker shall be provided with an closing and emergency manual trip, mechanical ON-OFF indicator, an operation counter, mechanism charge/discharge indicator, and electrical anti-pumping feature. In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose : (a) Position/cell switch with minimum 4NO + 4NC contacts. (b) Auxiliary switch, with minimum 6NO +6NC contacts, mounted on the stationary portion of the breaker panel and operated mechanically by a sliding level from the breaker in SERVICE position. Alternatively, electrically reset-latching relay may be used for the purpose. The exact requirement contacts of the position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the Tenderers taking into account the scheme requirements spares. Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.	

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5.4.12	Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches shall be provided with minimum 2NO + 2NC contact.	
5.4.13	Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.	
5.5	<u>SWITCHES</u>	
5.5.1	Switches shall be triple/double pole, air break type and designed for duties as specified in Annexure-A. Motor duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.	
5.5.2	The switch shall have a 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.	
5.5.3	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.	
5.5.4	Wherever two incoming switches and one bus-section switch/breaker are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.	
	Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that only one of the two can be closed at a time.	
5.6	<u>A.C. STARTER</u>	
5.6.1	Contactors	
	(a) The contactors shall be three pole, air break type with non-bouncing silver/silver alloy contacts. The contactor shall be designed for duty as per Annexure-B attached.	

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	(b) Each contactor shall be provided with minimum 2 NO and 2 NC auxiliary contacts rated 10A at 240V A.C. The exact requirement of contacts shall be decided by the tenderer taking into account the scheme requirements and spares. (c) Contactors for forward and reverse direction of reversible drives shall preferably be both electrically and mechanically interlocked. (d) Reacceleration system to be adopted for Boiler MCC, Turbine MCC and Emergency MCC contactor operated motor feeder. (e) All the contactor, starters shall comply with the requirement of type 2 coordination as specified by IEC 60947-4-1.	
5.6.2	Thermal Overload	
	(a) Thermal overload relays shall be three elements, positive acting, ambient temperature compensated with adjustable settings. (b) Single phasing preventor shall be provided as an inbuilt feature of the thermal overload relay. (c) Relays shall be manual reset type with changeover contacts; Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK. (d) Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply. (e) Relays for fan motors having long starting time shall be saturable case C.T operated.	
5.7	<u>D.C. STARTER</u>	
5.7.1	DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push buttons, lamps, etc.	

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5.7.2	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 2mm.													
5.7.3	The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54. The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.													
5.7.4	Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.													
5.8	<u>CONTROL AND INDICATION</u>													
5.8.1	Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following : (a) One (1) TEST-LOCAL-REMOTE selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism. (b) Two (2) push buttons for TRIP and CLOSE (c) Indicating lamps on the front of the compartment : <table><tr><td>(i) Breaker open</td><td>- GREEN</td></tr><tr><td>(ii) Breaker closed</td><td>- RED</td></tr><tr><td>(iii) Breaker tripped</td><td>- AMBER</td></tr><tr><td>(iv) Spring charged</td><td>- WHITE</td></tr><tr><td>(v) Trip circuit healthy</td><td>- BLUE</td></tr><tr><td>(vi) Breaker in Test position</td><td></td></tr></table>		(i) Breaker open	- GREEN	(ii) Breaker closed	- RED	(iii) Breaker tripped	- AMBER	(iv) Spring charged	- WHITE	(v) Trip circuit healthy	- BLUE	(vi) Breaker in Test position	
(i) Breaker open	- GREEN													
(ii) Breaker closed	- RED													
(iii) Breaker tripped	- AMBER													
(iv) Spring charged	- WHITE													
(v) Trip circuit healthy	- BLUE													
(vi) Breaker in Test position														

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(vii) Breaker in service position

- 5.8.2 The general scheme of connections for control, interlock, and protection shall be developed by the Tenderers during detailed engineering stage.
- 5.8.3 Push buttons shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.
- 5.8.4 Each push-button shall have minimum two (2) NO and two (2) NC contacts rated 10A at 240 V A.C.
- 5.8.5 Selector switches shall be stay-put; rotary type with escutcheon plates marked to indicate the function and positions. Selector switch contacts shall be rated for 10A at 240 V A.C.
- 5.8.6 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.
- The exact requirements contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.
- 5.8.7 Lamps shall be LED type. LED lamp shall be made in accordance with InP Technology (Aluminium 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.
- 5.8.8 For control supply, two (2) nos. adequately rated (minimum 2kVA) 415/240V control transformers with necessary taps and auto changeover facility shall be provided. Auxiliary bus bars shall be used to distribute 240V AC control supply. The control supply of different modules shall be tapped individually from the auxiliary bus bars. Transformer ratings shall be so selected to facilitate 100% standby arrangement with adequate spare capacity.
- 5.8.9 DCDBs shall be provided with indication to monitor healthiness of the incoming DC supplies.

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5.8.10	Two nos (minimum 2kVA) space heater transformer shall be provided for bus section A and B for catering space heater supply to respective bus.	
5.8.11	For emergency MCC though there will be single bus section two nos control transformer and two nos space heater transformer to be provided.	
5.9	<u>METERS AND METER SELECTOR SWITCHES</u>	
5.9.1	All indicating instruments (96 x 96 mm) shall be switchboard types, with 240 Deg. scale, anti-glare glass and accuracy class of $\pm 2\%$ full scale. Each meter shall have zero adjuster on the front.	
5.9.2	Motor ammeters shall have an extended suppressed end-scale range to indicate starting current (6 to 8 times full-load current).	
5.9.3	Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four-position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.	
5.9.4	Energy meters suitable shall be provided as per Meters for Energy Accounting & Audit (MEAA) confirming to latest CEA's regulations. Energy meters shall be of accuracy class 0.2S.	
5.10	<u>CURRENT TRANSFORMER</u>	
5.10.1	Current Transformers shall be cast-resin type. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.	
5.10.2	Motor feeders rated 30 KW to below 75KW, shall be provided with CTs for metering. Motor feeders rated 75KW and above, separate CTs shall be provided for metering and protections SFU rated 100A and above for outgoing feeder shall be provided with CT and ammeter.	
5.10.3	Accuracy class of the current transformers shall be :	
	(a) Class PS for differential	

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(b) Class 5P20 for other relaying (c) Class 1.0 ISF < 5 for metering other than MEAA metering (d) Class 0.2S for MEAA metering. 5.10.4 Feeders 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 of which shall correspond to the normal range. 5.10.5 CT secondary shall be rated for 5 A for metering and 1 A for protection. 5.11 <u>VOLTAGE TRANSFORMER</u> 5.11.1 Voltage transformers shall be cast-resin and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For MEAA meter accuracy class shall be 0.2 5.11.2 High voltage windings of voltage transformer shall be protected by current limiting fuses. 5.11.3 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 switchgear is energised. 5.12 <u>PROTECTIONS</u> 5.12.1 The minimum protections to be provided for circuit breaker controlled feeders are listed below : (a) Incoming Feeders : 3-Inverse time O/C relays (51) for phase faults & Instantaneous O/C (50) with timer : 1-Inverse time O/C relay (51N) for Earth faults		

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(b) Outgoing Feeders (c) Motor Feeders 5.12.2 Bidder shall quote suitable digital/microprocessor based numerical relay for motor protection with following minimum facility as indicated below : (a) Overload protection. (b) Short circuit & SC back-up. (c) Current unbalance/Negative phase sequence (d) Ground fault. (e) Locked rotor protection The relay shall have facility for user interface capability, character display, keypad, and LED indicator and communication port along with licensed version software. : Under Voltage relay (27) with Timer (2) : REF Relay (64R) & stand by E/F Relay (64 F) shall be provided for all Transformer feed Incomers. : 2-Inverse time O/C relay (51) for phase fault 1-Inverse time O/C relay (51N) for Earth fault : All inverse time O/C relay shall be 1.3 sec version : Microprocessor based Numerical Protection for LT Motor 75KW and above		

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5.12.3 5.12.4 5.13 5.13.1	Apart from protection relays, each electrically operated breaker shall be provided with antipumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type. Fuse Failure relay shall be provided on the secondary side of voltage transformer to monitor H.V. & L.V. fuses. <u>RELAYS</u> General-A - All relays & timers in the protection circuit shall be flush mounted with connection from inside. They shall have transparent, dust tight covers, removable from the front. They shall have built-in testing facilities. Except small auxiliary relays and timers, all relays shall be drawout type. - Relays shall be rated for operation on 1A secondary current and 110V secondary voltage to be decided by the bidder. Number and rating of relay contacts shall suit the job requirements. - The Bidder shall furnish, install & co-ordinate all relays to suit the requirements of protection, interlock and bus transfer schemes as broadly indicated in the annexures and drawings. Application check shall be made on all motor protection relay motor characteristics. The result of such check shall be furnished for approval. - It shall be the responsibility of the Bidder to fully co-ordinate the overload and short circuit tripping of the circuit breakers with the upstream and downstream circuit breakers/motor starters to provide satisfactory discrimination. - All setting devices shall be accessible after removing the front cover. No relay shall be mounted on the rear side of PCC /PMCC panel. - All relay coils and their auxiliary contacts (including un-enabled relays in Composite Numerical Relays, if any), including spare contacts will be wired up to the terminal blocks of respective panels for wiring to DCS & SCADA and for future use.	

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- (g) Parameterization and loading and downloading of data shall be possible from local HMI and as well as from DCS / SCADA.
- (h) All numerical relays shall have front communication port for parameterization, loading and downloading of data thru' Laptop.
- (i) All numerical relays and multi-functional meters shall be hooked up and connected with HMI through Fiber Optic cable.
- (j) Interposing relays (24V DC) with freewheeling diodes for signal exchange between Switchgear & DDCMIS/EDMS/PLC shall be provided in switchgear/PCC/PMCC module for controlling each feeder.
- (k) All DDCMIS/DCS/PLC operated motor feeders of any rating shall have ammeter & current transducer at "Y" phase.

5.13.2 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.

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5.13.3 Technical Requirement

(a) Auxiliary Power Supply

Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240V with tolerance of $\pm 20\%$. 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

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software selectable. (ii) All relays shall have LED/ LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65°C for contrast and legibility. (iii) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on. (iv) The relay shall have at least 6 programmable LEDs on relay front. (d) Software Security Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, settings, and status and event data as read only parameters should be without password protection. (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 selfreset 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.		

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(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 103 protocols. (iv) It shall be also possible for Relay Parameterization as well Downloading of Disturbance Records from PC provided in Unit & Engineering Workstations located in Switchgear Room of each unit i.e. Unit & Engineering Workstations shall be provided each in four (4) Switchgear Rooms. Necessary software to be provided for this purpose. Communication protocol shall be selected from relay to PC to provide all information. 5.14 <u>SECONDARY WIRING</u> 5.14.1 Allboards shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.		

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5.14.2	Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired up to terminal blocks.	
5.14.3	Wiring shall be done with flexible, 1100 V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 mm ² for current circuit and 1.5mm ² control (grey colour) and voltage circuit. Colour code shall be maintained for voltage and current circuit.	
5.14.4	Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block no., terminal nos., destination no. as per approved Drawing.	
5.14.5	Wire terminations shall be made with crimping type connectors with solder as insulating sleeves. Wires shall not be spliced between terminals.	
5.15	<u>TERMINAL BLOCKS</u>	
5.15.1	Terminal blocks shall be 660V grade box-clamp type 10 mm ² minimum with marking strips. Terminals for C.T. secondary leads shall have provision for shorting.	
5.15.2	Terminal blocks used for interface with DCS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.	
5.15.3	Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.	
5.15.4	Terminal blocks 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.	
5.16	<u>CABLE TERMINATION</u>	
5.16.1	Generally all assemblies shall be designed for cable entry from the bottom. Sufficient space shall be provided for all the cables as per cable schedule, for ease of termination and connection.	

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5.16.2	All provisions and accessories shall be furnished for termination and connection of cables as per cable schedule, including removable gland plates, cable support, crimp type tinned copper/aluminium lugs, double compression brass glands with tapered washer (Power cable only) and terminal blocks.	
5.16.3	Gland plates shall be minimum 4 mm thick. The gland plate and supporting arrangement for 1/C power cables shall be non-magnetic type to minimise the flow of eddy current.	
5.17	<u>BUS DUCT CONNECTION</u>	
5.17.1	Bus duct connection, wherever provided, shall be furnished along with transition panel, if required. Bus duct connections shall be from the side.	
5.17.2	All connecting bus work shall have the same continuous rating as associated PCC/PMCC/MCC/DB bus and shall be fully braced for the LT system short circuit current.	
5.17.3	All provisions such as matching flanges and other accessories required for proper connection to bus duct shall also be supplied.	
5.18	<u>GROUND BUS</u>	
5.18.1	A ground bus, rated to carry maximum fault current, shall be provided which shall extend the full length of the assembly.	
5.18.2	The ground bus shall be provided with two-bolt drilling with GS bolts and nuts at each end and shall be suitable to receive 50 x 6 mm G.S. flat.	
5.18.3	All stationary units shall be directly connected to the ground bus for effective grounding.	
	The frames of all circuit breakers and V.T. units shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.	
	The frames of all other drawout modules shall be grounded at all times except when the power disconnects are separated by a safe distance.	

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5.18.4	Wherever the schematic diagrams indicate a definite ground at the switchgear; a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.	
5.18.5	C.T. & V.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.	
5.18.6	All hinged doors shall be earthed by flexible copper braid.	
5.19	<u>NAMEPLATES</u>	
5.19.1	Nameplates of approved design shall be provided on each cubicle, at the top of the assembly and on each instrument & device mounted on or inside the cubicle.	
5.19.2	The material shall be lamicaid or approved equal. 3 mm thick with white letters on black background.	
5.19.3	The nameplates shall be held by self-tapping screws. Nameplate size shall be minimum 40 x 150 mm for instrument/devices & 75 x 450 mm for panels.	
5.19.4	Caution notice on suitable metal plate shall be affixed both at the front and back of each vertical panel.	
5.20	<u>SPACE HEATERS AND PLUG SOCKETS</u>	
5.20.1	Each vertical section shall be provided with thermostat controlled space heater and 5A, 3-pin plug socket.	
5.20.2	In addition, motor feeders rated 30 kW and above shall be wired-up for feeding the motor space heater through suitably rated breaker auxiliary NC contact and/or contactor.	
5.20.3	Cubicle heater, Motor heater, and Plug-socket circuit shall have individual switch fuse units.	

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5.21	<u>A.C./D.C. POWER SUPPLIES</u>	
5.21.1	Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor.	
5.21.2	Isolating switch fuse units shall be provided for the incoming supplies. These shall be 4-pole, single throw for 415V AC and 2- pole double throw without off position for 220V DC.	
5.21.3	Bus-wires of adequate capacity shall be provided to distribute the incoming supplies for different cubicles. Isolating switch- fuse units shall be provided at each cubicle for A.C. /D.C. supplies.	
5.21.4	A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.	
5.22	<u>TROPICAL PROTECTION</u>	
5.22.1	All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.	
5.22.2	Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.	
5.23	<u>PAINTING</u>	
5.23.1	All assemblies shall be finished with two coats of RAL7032 shade.	
6.0	<u>TESTS</u>	
6.1	The switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards..	
6.2	<u>ROUTINE TESTS</u>	
	The tests shall include but not necessarily limited to the followings:	
	(a) Operation under simulated service condition to ensure accuracy	

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of wiring, correctness of control scheme & proper functioning of the equipment. (b) All wiring and current carrying parts shall be subjected to appropriate High Voltage Test. (c) Primary current & voltage shall be applied to all instrument transformers. (d) Routine test shall be carried out on all equipment such as circuit breakers, instrument transformers, relays, meters, contactors, switch-fuses, etc. 6.3 <u>TYPE TESTS</u> The following type tests shall be performed on a representative sample of the LV Switchgear assembly, type test certificates of these tests shall be submitted by the Bidder for Purchaser's approval : (a) Temperature rise Test (b) Short circuit test should be performed so that one complete (longest) span of insulator supports of main busbars are covered in the S.C path thereby subjected to dynamic forces developed. Short circuit test shall be performed in the following section of the busbar:- Circuit Breaker Panel: In the main horizontal busbar and vertical bus bar with ACB replaced by shorting link. Motor Control Centre / Distribution Boards:- Main horizontal busbar, Vertical busbar. 6.4 Type test can be waived off for LV Switchgear on producing type test certificates conducted within last five (5) years for identical LV Switchgear. Type tests shall be conducted by successful bidder for LV Switchgears for which type test certificates are not available for identical LV Switchgear, conducted within last 5 years.		

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6.5 TEST WITNESS

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

(B) 415V NON SEGREGATED BUSDUCT

1.0 GENERAL

1.1 The busduct will serve as interconnection between L.V terminals of Auxiliary L.T Transformers to their respective PCC/PMCC and also for trunking connection between each set of PCC/PMCC, if required.

1.2 The busduct shall be non-segregated type, self-cooled. The cooling medium inside the duct shall be air.

1.3 The busduct will be installed in a hot, humid and tropical atmosphere.

1.4 For continuous operation at specified rating, maximum temperature of the busduct shall be limited to the following, considering 50°C as ambient temperature :

(a) Bus Conductor/Bus Connection

(i)	with silver plated joints	:	105° C
(ii)	with plain or tin joints	:	90° C
(iii)	Bus Enclosure/Supports	:	80° C
(iv)	Bus conductor	:	85 ° C

(b) It shall be capable of withstanding the mechanical forces and thermal stresses of the specified short-circuit currents without any damage or deterioration of material.

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(c) Wherever expansion joints are required neoprene rubber bellows shall be provided for enclosure and flexible connectors for conductor 1.5 Same phase disposition shall be maintained throughout the run of the bus duct. Phase cross-over units, if required, shall also be provided. 1.6 The minimum distance between transformer terminal box of LT side and MCC terminal box shall be 1500mm. 2.0 <u>ENCLOSURE</u> 2.1 All the three phases shall be enclosed in a weather proof, dust tight enclosure. Outdoor section of the busduct shall be completely rain proof. For bus rating including and above 2000 A, enclosure shall be of aluminium and for bus rating below 2000 A, enclosure shall be of sheet steel fabricated type. Minimum Degree of protection of busduct enclosure shall be IP-54 for indoor and IPW-55 for outdoor section of the busduct. 2.2 Weather resistant type circumferential gaskets shall be provided for making the joints with adjacent enclosures dust-proof and imperious to moisture. 2.3 The connection flanges shall be sufficiently stiffened so as not to bend while tightening the bolts. 2.4 Suitable inspection opening with gaskets shall be provided for access to support insulator, bus joints etc. 3.0 <u>BUS CONDUCTOR</u> 3.1 The conductor shall be of high conductivity aluminium /aluminium alloy sized for the same rating as associated PCC/PMCC bus. for rating above 2000A conductor shall be copper. 3.2 Joints made at the factory shall be welded type and the joints to be made at site shall be bolted type.		

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3.3	For bolted rigid/expansion joints, necessary bolts, nuts, (cadmium plated) washers and other hardwares shall be supplied.	
3.4	Busbars shall be colour coded at regular intervals for easy identification. The markings on the bars shall be Red for R-phase, Yellow for Y-phase, and Blue for B-phase.	
3.5	For each shipping section, the bus conductor shall be supported at minimum two positions.	
4.0	<u>BUS-BAR SUPPORT</u>	
4.1	All buses and connections shall be supported and braced to withstand stresses due to maximum short circuit current.	
4.2	The bus conductor supporting insulators shall be flame retardant, non-hygroscopic, high strength track resistant type with high creepage surface.	
4.3	The insulators shall be so located that they can be easily removed and replaced without dismantling the busduct installation.	
4.4	Space heater shall be provided near each insulator to avoid moisture condensation within busduct.	
4.5	The number and wattage of space heaters shall be decided by the Tenderers.	
5.0	<u>SUPPORTING STRUCTURES</u>	
5.1	All supporting structures required for hanging and/or supporting the complete busduct shall be furnished. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.	
5.2	All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces, and all specified design loads.	

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5.3	All steel members shall be hot-dip galvanised after fabrication. All hardware shall be of high strength steel with weather resistant finish.	
5.4	For each shipping section, the enclosure shall be supported at minimum two positions.	
5.5	The enclosure supporting arrangement shall be such that the busduct load is not transmitted onto the terminations.	
6.0	<u>CONNECTIONS AND TERMINATIONS</u>	
6.1	All matching flanges, seal-off bushings, gaskets, fittings, hardware, and supports required for termination of the busduct at PCC/PMCC, transformer, and any other equipment shall be supplied.	
6.2	All hardware used at conductor points shall be of non-magnetic, high tensile material.	
6.3	Expansion joints for both conductor and enclosure shall be provided as follows:	
	(a) At all equipment terminations	
	(b) On either side of seal-off bushings	
6.4	Expansion joints shall be provided on bus conductor and enclosure to take care of thermal expansion.	
6.5	Seal-off bushing with wall frame assembly shall be provided wherever the busduct penetrates the building wall from outdoor to indoor.	
6.6	Equipment terminal connection shall be readily accessible and shall provide sufficient air gap for isolation of equipment during testing.	
6.7	If the material of bus conductor and that of the equipment terminal connectors are different, suitable bi-metallic connectors shall be provided.	

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7.0	<u>GROUND BUS</u>	
7.1	A ground bus rated to carry maximum fault current shall be provided running the entire length of the busduct on both sides. Grounding all parts of the supporting structure and each enclosure section.	
7.2	The ground bus shall be provided with two-bolt drilling with GS bolts and nuts at each end to receive 50 x 6 mm G.S. flat.	
8.0	<u>FINISH</u>	
8.1	Except for supporting steel structures, which shall be galvanised, all other material, shall be finished with a undercoat of high quality primer followed by two coats of synthetic enamel paint.	
8.2	The interior surface finish shall be as per manufacturer's standard. The shade of exterior surface finish will be Siemens grey RAL 7032	
8.3	Pre-treatment consisting of degreasing, derusting etc. shall be done on all fabricated parts before painting or galvanising.	
8.4	Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale off or crinkle or are removed by abrasion due to normal handling.	
8.5	Sufficient quantities of all paints and preservatives required for touching up at site shall be furnished.	
9.0	<u>TESTS</u>	
9.1	The busduct shall be completely assembled and checked at the factory for correctness of alignment.	
10.0	<u>ROUTINE TESTS</u>	
	Busduct shall be subjected to the following tests:	
	(a) Visual inspection and verification of dimensions.	

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(b) Dry power frequency voltage withstand test for 1-min. (c) Insulation resistance measurement. (d) Milli-volt drop test. 10.1 <u>TYPE TESTS</u> The following type tests shall be performed on a representative section of bus assembly: (a) Impulse voltage withstand test. (b) Heat run test. (c) Short circuit test. (d) Water tightness test. (e) Air tightness test Type test can be waived off for LV Busduct on producing type test certificates conducted within last five (5) years for identical LV Busduct (Same rating and same dimensions). Type tests shall be conducted by successful bidder for LV Busduct for which type test certificates are not available for identical LV Busduct, conducted within last 5 years. 10.2 <u>MISCELLANEOUS COMPONENTS</u> Tests on insulators, etc. shall be carried out as specified in relevant standards. 11.0 <u>TEST WITNESS</u> Tests shall be performed in presence of Owner/Purchaser's representative if so desired by the Owner/Purchaser. The contractor shall give at least thirty (30) day's advance notice of the date when the tests are to be carried out.		

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415V LT SWITCHBOARD

DATA SHEET – A

<u>SR. NO.</u>	<u>ITEM</u>	<u>UNITS</u>		
1.0	<u>GENERAL</u>			
(a)	Type		Metal-clad, drawout (PCC / PMCC / MCC / SVB) Metal-clad, fixed (DB)	
(b)	Service		Indoor	
(c)	Enclosure		For ampere rating up to 1600A – degree of protection of PCC / PMCC / MCC shall be IP-54 and above 1600A the degree of protection will be IP-42	
1.1	<u>SYSTEM</u>		AC	DC
(a)	Voltage	V	415V ± 10%	220V ± 10%
(b)	Phase		3-phase and neutral	-
(c)	Combined voltage and frequency variation		±10% (absolute sum)	-
(d)	System grounding		Solidly grounded	Ungrounded
1.2	<u>RATED CURRENT AT 50°C AMBIENT</u>			
(a)	Busbar		* By Bidder	
(b)	Circuit breaker		* By Bidder	
(c)	Switches		16A to 400A	

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNITS</u>		
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	240V AC $\pm$ 10%, 1 Ph, 50 Hz $\pm$ 5%	
(c)	Service voltage	V	240V 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	50 kA	
2.3	<u>MAKING CURRENT</u>	kA	125 kA 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

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNITS</u>		
			Class III-Category AC3 for unidirectional bi-directional/inching duty drives	Class I - Category DC2
4.0	<u>BUSBAR INSULATOR</u>		Epoxy/Eparchy	

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415V NON SEGREGATED BUSDUCT

DATA SHEET – A

<u>SR NO.</u>	<u>ITEM</u>	<u>UNITS</u>	
1.0	<u>GENERAL</u>		
1.1	Type		Non-segregated
1.2	Service		Indoor/Outdoor
1.3	Material enclosure		Sheet steel / aluminium
1.4	Conductor		Aluminium / Aluminium alloy / copper
1.5	Thickness of enclosure	mm	2 mm for sheet steel 3 mm for aluminium (min)
2.0	<u>SYSTEM</u>		
2.1	Voltage	V	415V AC $\pm 10\%$
2.2	Phase		3-Phase and neutral
2.3	Frequency	Hz	50 Hz $\pm 5\%$
2.4	Combined voltage and Frequency variation		$\pm 10\%$ (absolute sum)
3.0	Service voltage (for space heater)	V	240V AC $\pm 10\%$, 1-Phase
4.0	Rated current at 50°C ambient		To be decided by the Tenderers
5.0	Short time current rating	kA	50
6.0	For one (1) second	kV	2.5 kV (rms)
7.0	One (1) minute power frequency withstand voltage (minimum) (over 50°C ambient)		
7.1	Bus conductor		

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(a)	With Silver Plated bolted joints	°C	55°C	
(b)	With Plain or Tin joints	°C	40°C	
7.2	Bus enclosure and structure	°C	30°C	
8.0	Busbar Insulator		Epoxy/Eparchy	

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ANNEXURE – A

INDICATIVE LIST OF 415V PCCs/PMCCs/ MCCs/ DBs/ SVBs/FBs/DC STARTERS

1.0	<u>PCC/PMCC/MCC</u>		
1.1	415 V Unit PCC	:	1 no.
1.2	ESP AC & Ventilation MCC	:	1 no.
1.3	415 V Station PCC	:	1 no.
1.4	ID Fan MCC	:	1 no.
1.5	415 V Emergency MCC	:	1 no.
1.6	415 V ESP PCC	:	6 nos.
1.7	415 V Turbine MCC	:	1 nos.
1.8	415 V Boiler MCC	:	1 no.
1.9	415 V Soot Blower MCC	:	1 no.
1.10	415 V HVAC MCC	:	1 no.
1.11	415 V Service building MCC	:	1 no.
1.12	415 V Fire Water PMCC	:	1 no.
1.13	415 V Cooling Water PMCC	:	1 no.
1.14	415 V Fuel oil pressurising MCC	:	1 no.
1.15	415 V Welding Board	:	1 no.
1.16	415 V Lighting Board	:	1 no.
1.17	415 V DG PCC	:	1 no.
1.18	415 V Silo Area MCC	:	1 no.

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1.19	415 V Ash Handling PMCC	:	1 no.
1.20	415 V Ash Slurry Pump House MCC	:	1 no.
1.21	415 V Ash water & Clarifier MCC	:	1 no.
1.22	415 V Fly Ash MCC / HCSD MCC	:	1 no.
1.23	415 V Bunker PMCC	:	1 no.
1.24	415 V Main CHP PMCC	:	1 no.
1.25	415 V Wagon Tripler PMCC	:	1 no.
1.26	415V Pre Treatment Plant MCC	:	1 no.
1.27	415 V Ozonation MCC	:	1 no.
1.28	415 V Raw Water PMCC	:	1 no.
1.29	415 V ETP MCC	:	1 no.
1.30	415 V STP MCC	:	1 no.
1.31	415 V Fuel Oil Transfer MCC	:	1 no.
1.32	415V Work shop MCC	:	1 no.
1.33	415V Post Treatment Plant MCC	:	1 no.
2.0	<u>415V ACDBS</u>		
2.1	Station ACDB	:	1 no.
2.2	Lighting Distribution Board	:	1 no.
2.3	Welding Transformer Board In Power House	:	1 no
2.4	ACDBs for balance areas	:	4 no
3.0	<u>220V DCDBS</u>		
3.1	Main DCDBs for power block (BTG) area & balance area.		

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4.0	<u>SVBS</u>		
4.1	DC SVBS	:	1 no.
4.2	AC SVBS	:	1 no.
5.0	<u>DC STARTERS</u>	:	1 No. for each D.C drive
6.0	<u>415V NON SEGREGATED PHASE BUS DUCT</u>	:	As required

NOTE: This list is an indicative one, based on information available for existing plant. The exact number of boards shall be finalized by the tenderers. In case additional boards are required which have not been included in this list, the same shall also be included by the tenderers in their scope.

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ANNEXURE – B

MODULE SELECTION

1.0 MOTOR FEEDER

Type	Motor Rating	Switch Fuse Rating	Contactor	Cable size	Module Size
AU/AR	0 - 5.5 kW	32A	16A	3/c - 2.5 Sq.mm - Cu	400 mm
BU/BR	5.6 - 11 kW	63A	32A	3/c - 16 Sq.mm - Al	400 mm
CU	11.1 - 29.9 kW	63A	63A	3/c - 35 Sq.mm - Al	600 mm
DU	30 - 36 kW	100A	100A	3/c - 95 Sq.mm - Al	900 mm
	37 - 45 kW	125	100A		
EU	50.1 - 75 kW	200A	160A	3/c - 185 Sq.mm - Al	900 mm
FU	75.1 - 89.9kW	200A	185A	2 x 3/c - 185 Sq.mm - Al	900 mm

NOTE :

1. Switch Fuse, thermal overload relay, Contractor are to be co-ordinated (Type-2) with motor rating by the Contractor.
2. "U" stands for Unidirectional and "R" for Reversible drives.
3. Minimum module height of module shall be 400mm

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2.0 OUTGOING FEEDER

Type	Switch Fuse Rating	Cable Size	Module Size
AF	32A	4/c – 16 Sq.mm - Cu	200 mm
BF	63A	4/c – 35 Sq.mm - Al	200 mm
CF	100A	3.1/2 – 95 Sq.mm - Al	300 mm
DF	200A	3.1/2 – 300 Sq.mm - Al	400 mm
EF	400A	4 x 1/c – 630 Sq.mm - Al	600 mm

3.0 MODULE SELECTION

Type	Switch Rating	Fuse Rating	Cable Size	Module Size
DAU	16A	16A	2/C-2.5 Sq.mm. Cu.	200 mm
DAF	32A	32A	2/C-2.5 Sq.mm. Cu.	200 mm
DBF	63A	63A	2 x 2/C-16 Sq.mm - Al	200 mm
DCF	100A	100A	4/C-35 Sq.mm - Al	300 mm
DDF	200A	200A	2 x 4/C-35 Sq.mm - Al	400 mm
DEF	400A	400A	2 x 1/C-630 Sq.mm - Al	600 mm

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 1 OF 2		BIDDER/ : VENDOR		STANDARD QP NO. : PE-QP-999-509-E001, REV. 0		SPECIFICATION TITLE:			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SYSTEM CAT.	EARTHING TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	DOC. NO. : AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
1.0	RAW MATERIAL										
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	1/2	Refer note in Remark at Sl. No.3
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-	
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2
2.0	IN-PROCESS										
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	QC RECORD	2	-	1
		2.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-
BHEL											
PARTICULARS			BIDDER/VENDOR								
NAME											
SIGNATURE											
DATE											
LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION											
BIDDER'S/VENDORS COMPANY SEAL											

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :						
	BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-509-E001 REV. 0		SPECIFICATION TITLE:								
S/ COMPONENT/OPERATION NO.	SHEET 2 OF 2	CHARACTERISTIC CHECK	SYSTEM CAT.	EARTHING TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	DOC. NO. : AGENCY	REMARKS			
										P	W	V	
1	2	3	4	5	6	7	8	9	10	11			
2.3	GALVANISING	1.TEMPERATURE OF BATH 2. DROSS 3. RATE OF IMMERSION 4.SURFACE QUALITY	MA MA MA MA	TEMPERATURE INDICATOR VISUAL VISUAL/ MEASUREMENT VISUAL	CONTINUOUS PERIODIC 100% 100%	IS - 2629 IS - 2629 IS - 2629/ MFRS PRACTICE IS - 2629	IS - 2629 IS - 2629 IS - 2629/ MFRS PRACTICE FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD QC RECORD QC RECORD QC RECORD	3/2 3/2 3/2 3/2	- - 2 -	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM, then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.		
3.0	FINISHED ITEMS	1. CHEMICAL 2.DIMENSIONS 3.SURFACE FINISH	MA MA MA	CHEMICAL MEASUREMENT VISUAL	1 No./LOT/SIZE IS 2500 (PART 1) LEVEL S-4 IS 2500 (PART 1) LEVEL S-4	IS-2062 APP. DATA SHEET/ APP. DRAWING FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	IS-2062 APP. DATA SHEET/ APP. DRAWING FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	LAB TC INSP. REPORT INSP. REPORT	2 2 2	- 1 1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab		
		4.MASS OF ZINC COATING 5.UNIFORMITY OF ZINC COATING 6.THICKNESS OF ZINC COATING 6.ADHESION	MA MA MA MA	CHEM. TEST CHEM. TEST ELCOMETER MECH. TEST	IS - 4759 IS - 4759 IS - 4759 IS-4759	IS-6745 / APP. DATA SHEET IS-2633 APP. DATA SHEET IS-2629	APP. DATA SHEET IS-2633 APP. DATA SHEET IS-2629	INSP. REPORT INSP. REPORT INSP. REPORT INSP. REPORT	2 2 2 2	1 1 1 1			
BHEL													
PARTICULARS			BIDDER/VENDOR										
NAME													
SIGNATURE													
DATE													
LEGEND :			1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB- VENDOR	P - PERFORM	W - WITNESS	BIDDER'S/VENDORS COMPANY SEAL					
								V - VERIFICATION					

QUALITY PLAN			CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :				
BIDDER/ VENDOR			BIDDER/ VENDOR			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
SHEET 1 OF 5			ITEM :ILLUMINATION									
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY		REMARKS	
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	LUMINAIRES & LAMPS	1. ACCEPTANCE TEST										
		a) VISUAL	MA	VISUAL	IS 10322 (PART5 SEC1)	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	1	-	AFTER SUCCESSFUL COMPLETION OF 1a, 1b & 1c FURTHER TESTING OF 1d) TO BE DONE BY PAPER INSERTION METHOD.
		b) IR (Dry)	CR	ELECTRICAL	IS 10322	-DO-	-DO-	-DO-	3/2	1	-	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		d) DUST PROOF	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		e) PHOTOMETRIC	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1*	-	*: ONE NO. LUMINAIRE OF EACH TYPE TO BE WITNESSED BY BHEL MAIN VENDOR TO WITNESS AS PER IS-10322.
		2. ROUTINE TEST										
		a) VISUAL	MA	VISUAL	100%	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	-	1	
		b) IR (Dry)	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		3. TYPE TEST	MA	ELECTRICAL	ONE OF EACH TYPE	IS 10322 IEC-62384/61347 FOR LED	IS 10322 IEC-62384/61347 FOR LED	TEST REPORT	3/2	-	1**	** Refer note 3 & 4
2.0	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS/ FEEDER PILLAR	1.DIMENSIONS	MA	MEASUREMENT	10%	APPD DRG.	APPD DRG.	INSPT. REPORT	3	2,1	-	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	-DO-	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/ SIZE & RATING	APPD DRG./DATA SHEET RELEVANT IS	APPD DRG./DATA SHEET RELEVANT IS	TEST CERT	-	-	2,1	
		4.FUNCTIONAL TEST	MA	ELECT.	100%	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		5.HV/IR/HV	MA	ELECT	100%	2.5KV AC FOR 1 MINUTE	2.5KV AC FOR 1 MINUTE	INSPT. REPORT	3	2,1	-	
BHEL			PARTICULARS		BIDDER/VENDOR							
			NAME									
			SIGNATURE									
			DATE									
LEGEND :			1 - BHEL/CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	BIDDER'S/VENDORS COMPANY SEAL					
						W - WITNESS	V - VERIFICATION					

QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :							
SHEET 2 OF 5		BIDDER/ VENDOR		STANDARD OF NO. : PE-QP-999-558-E001, REV.0		SPECIFICATION TITLE :							
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	ITEM ILLUMINATION	DOC. NO. :						
1	2	3	4	5	6	7	8	9	10	11			
3.0	LIGHTING TRANSFORMER	6. TYPE TEST	MA	ELECT	1/RATING	IS: 8623 (PART-1)/ IEC-439-1/IS60947/ APPD DATA SHEET	IS: 8623 (PART-1)/ IEC-439-1/IS60947/ APPD DATA SHEET	TEST REPORT	3/2	1**			
		1. ROUTINE TEST											
		a) TYPE / RATING	CR	VISUAL	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		b) WIND. RESISTANC	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		c) V. RATIO /VECTOR	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		d) Z VOLT/ Z SCKT	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		e) LOAD LOSS/ CURRENT	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		f) NO LOAD LOSS	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		g) SOURCE WITHSTAND	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		h) INDUCED O/V	CR	TEST	100%	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
4.0	CONDUITS	2. TYPE TEST	MA	TEST	1/RATING	IS 11171 /APPD DRG./DATA SHEET	IS 11171 /APPD DRG./DATA SHEET	TEST REPORT	3/2	1**			
		1.MATERIAL	MA	VISUAL,MECH. & CHEMICAL	APPD DATASHEET/ IS 9537	IS 9537	IS 9537	INSPT. REPORT	3	2	1		
		2.DIMENSIONS	MA	MEASUREMENT	APPD DATASHEET/ IS 9537	IS 9537	IS 9537	INSPT. REPORT	3	2	1		
		3. MECH. PROPERTIES											
		a) BENDING TEST	CR	TEST	IS 9537-II	IS 9537	IS 9537	INSPT. REPORT	3	2.1	-		
		b) COMPRESSION	CR	TEST	IS 9537-II	IS 9537	IS 9537	INSPT. REPORT	3	2.1	-		
		c) BEND	CR	TEST	BHEL APPPD DATASHEET/ IS 9537	APPDD DATASHEET/ IS 9537	APPDD DATASHEET/ IS 9537	INSPT. REPORT	3	2.1	-		
		4. GALVANISATION TEST											
		a) ZINC COATING	CR	TEST	IS 9537-II	IS-2633	IS-2633	INSPT. REPORT	3	2.1	-		
		BHEL		PARTICULARS		NAME		BIDDER/VENDOR		BIDDER'S/VENDORS COMPANY SEAL		V - VERIFICATION	
		SIGNATURE		DATE				W - WITNESS					
LEGEND :		1 - BHEL/CUSTOMER		2 - VENDOR		3 - SUB- VENDOR		P - PERFORM		BIDDER'S/VENDORS COMPANY SEAL		V - VERIFICATION	

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :		
				BIDDER/ VENDOR :		STANDARD OP NO. : PE-OP-999-568-E001, REV.0		SPECIFICATION TITLE :		
SHEET 3 OF 5				SYSTEM		ITEM ILLUMINATION		DOC. NO. :		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	REMARKS	
1	2	3	4	5	6	7	8	9	10	
									P W V	
5.0	ELECTRIC POLES	b) MASS OF ZINC COAT.	CR	TEST	IS 9537-II	IS-6745/4759/ APPD DATASHEET	IS-6745/4759/ APPD DATASHEET	INSPT. REPORT	3 2,1 -	BYELCOMETER
5.1	MATERIAL	c) COATING THICKNESS	CR	TEST	IS 9537-II	IS-9537/ APPD DATASHEET	IS-9537/ APPD DATASHEET	INSPT. REPORT	3 2,1 -	
		d) EPOXY THICKNESS	MA	VISUAL/PHYSICAL	IS 9537-II	50 MICRONS	50 MICRONS	INSPT. REPORT	3 2,1 -	
		1.CHEMICAL COMP.	MA	CHEM. ANALYSIS	IS 2713	IS-2713 IS-228 & IS-1608	IS-2713 IS-228 & IS-1608	-DO-	3/2 - 2,1	
5.2	FINAL INSPECTION	2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2 - 2,1	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL
		1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	IS 2713	APPD DRG./ IS-2713	APPD DRG./ IS-2713	-DO-	3/2 2,1 -	
		2.DIMENSIONS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2 2,1 -	
		3.WEIGHT	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2 2,1 -	
		4.TESTS AS PER IS-2713	MA	-DO-	-DO-	IS-2713	IS-2713	-DO-	3/2 2,1 -	
BHEL										
PARTICULARS										
NAME										
SIGNATURE										
DATE										
BIDDER/VENDOR										
BIDDER'S/VENDORS COMPANY SEAL										
LEGEND : 1 - BHEL/CUSTOMER 2 - VENDOR 3 - SUB-VENDOR P - PERFORM W - WITNESS V - VERIFICATION										

गोपनीय BHEL		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :							
		QUALITY PLAN		BIDDER/ VENDOR		SPECIFICATION TITLE :							
		SHEET 4 OF 5		SYSTEM		ITEM :ILLUMINATION		DOC. NO. :					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
6.0	HIGH MAST												
6.1	High Mast Shaft	a) Dimensional conformity b) Galvanising	MA MA	MEASURE MEASURE	10% or Min. 2 Nos -do-	APPD DRG. DATASHEET	APPD DRG. DATASHEET	TEST CERTIFICATE -do-	3	2,1	-	-	
6.2	Head Frame	a) Dimensional conformity	MA	MEASURE	-do-	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-do-	3	2,1	-	BY ELOOMETER	
6.3	Lantern Carriage	a) Dimensional conformity b) Galvanising	MA MA	MEASURE MEASURE	-do- -do-	-do- -do-	-do- -do-	-do- -do-	3	2,1	-	-	
6.4	Double drum Winch	a)Load Capacity	MA	MEASURE	-do-	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor	
6.5	Stainless Steel Wire Ropes	a) Breaking Capacity	M	MEASURE	100%	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor	
6.6	FEEDER PILLAR								Test for feeder pillar shall be as per S. No. 2				
7.0	JUNCTION BOXES & RECEPTACLES	1.DIMENSIONS 2.PAINT SHADE/ THICKNESS 3.HV/IR/HV 4.DEGREE OF PROTECTION 5.SPECIAL TESTS IF ANY.EXPLOSION PROOF. 6. OPERATION CHECK 7. MECHANICAL INTERLOCK	MA MA MA MA MA MA MA	MEASUREMENT VISUAL/MEAS. ELECT TESTS TEST TEST TEST TEST	100% 10% 100% 1/SIZE 1/SIZE 10% 10%	APPD DRG/ DATASHEET APPD DRG/ DATASHEET 2KV AC FOR 1 MINUTE IS 2147/ APPD DRG IS 2147/ APPD DRG	APPD DRG/ DATASHEET APPD DRG/ DATASHEET 2KV AC FOR 1 MINUTE IS 2147/ APPD DRG IS 2147/ APPD DRG	INSP. REPORT -DO- -DO- TEST CERT. TEST CERT.	3 3 3 3 3 3 3	- - - - - - -	2 2 2 2,1 2,1 2 2	COMPONENTS TO BE OF APPROVED MAKE	
BHEL		PARTICULARS		BIDDER/VENDOR									
		NAME											
		SIGNATURE											
		DATE											
LEGEND :		1 - BHEL/CUSTOMER	2 - VENDOR	3 - SUB- VENDOR	P - PERFORM	W - WITNESS	V - VERIFICATION	BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 5 OF 5		BIDDER/ VENDOR		STANDARD QP NO. : PE-OP-993-558-E001, REV.0		SPECIFICATION TITLE :			
SYSTEM		ITEM ILLUMINATION		DOC. NO. :							
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	REMARKS		
1	2	3	4	5	6	7	8	9	10		
8.0	PVC WIRES	1.SURFACE DEFECTS	MA	VISUAL	10%	IS:694 IS:1554	IS:694 IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3	2.1	TO BE PROCURED FROM BIS APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	10%	-DO-	-DO-	-DO-	3	-	2.1
		3.ACCEPTANCE TESTS	MA	-DO-	IS: 694	-DO-	-DO-	-DO-	3	-	2.1
		4.ROUTINE TESTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2.1
		5.TYPE TESTS	CR	ELEC.TESTS	ONE/TYPE & SIZE	IS:694 IS:1554	IS:694 IS:1554	TEST CERT.	3	-	1** ** Refer note 3 & 4
NOTES: 1. IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB. 2. ITEMS LIKE CEILING FANS, EMERGENCY LIGHTING UNIT, FLEXIBLE CONDUIT, EARTHING WIRE & ELATS, 24V SUPPLY MODULE, LADDERS, HUMME PIPE, SWITCHBOXES, EXIT SIGNS, STRUCTURAL STEEL ETC. WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE). 3. TYPE TEST CERTIFICATES TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER. 4. CONDUCTION OF TYPE TESTS TO BE DONE IF REQUIRED BY BHEL TECHNICAL SPECIFICATION & TEST CERTIFICATES FOR THE SAME TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER. 5. TYPE TEST REPORT DULY VERIFIED BY BHEL ENGINEERING/CUSTOMER SHALL BE SUBMITTED FOR VERIFICATION DURING INSPECTION.											
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :		1 - BHEL/CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	W - WITNESS	V - VERIFICATION				

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		BIDDER/ VENDOR				STANDARD QP NO. : PE-QP-999-507-E006, REV. 0		SPECIFICATION TITLE:			
SHEET 1 OF 2		SYSTEM CABLING		ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)		DOC. NO. :					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	REMARKS		
1	2	3	4	5	6	7	8	9	10		
1	2	3	4	5	6	7	8	9	10		
1.0	RAW MATERIAL										
1.1	MILD STEEL SECTIONS (CHANNEL & ANGLES) AS PER SPECIFICATION	1.CHEMICAL & PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS -2062	IS -2062	MILL TC	3	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL Re Rollers.
1.2	ZINC	2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 808/ IS - 1852	IS - 808/ IS - 1852	QC RECORD	3/2	-	
2.0	IN-PROCESS	3.SURFACE FINISH	MA	VISUAL	100%	IS:2062	IS:2062	QC RECORD	3/2	-	
2.1	CUTTING	CHEM.COMP.	MA	CHEM. TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2
		1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET	APP. DATA SHEET	QC RECORD	2	-	1
		2. WELDING QUALITY (IF APPLICABLE)	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1
2.2	SURFACE PREPARATION	3.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1
		1.CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-
		2. SURFACE QUALITY	MA	VISUAL	100%	IS-2629	IS-2629	QC RECORD	2	-	-
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	3/2	-	-
											If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :		1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	W - WITNESS	BIDDER'S/VENDORS COMPANY SEAL				
										V - VERIFICATION	

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
	SHEET 2 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-507-E006, REV. 0		SPECIFICATION TITLE:			
	SL. NO.		SYSTEM		ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)		DOC. NO. :			
COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	REMARKS		
1	2	3	4	5	6	7	8	9		
3.0 FINISHED ITEMS	2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	10	11
	3. RATE OF IMMERSION	MA	VISUAL MEASUREMENT	100%	IS - 2629 / MFR'S PRACTICE	IS - 2629 / MFR'S PRACTICE	QC RECORD	3/2	-	2
	4. SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN, ETC.	QC RECORD	3/2	-	-
	1.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-
	2. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	INSP. REPORT	2	1	-
	3.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-
4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	INSP. REPORT	INSP. REPORT	2	1	-	
5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	INSP. REPORT	INSP. REPORT	2	1	-	
6.ADHESION	MA	MECH. TEST	IS-4759	IS-2629	INSP. REPORT	INSP. REPORT	2	1	-	
BHEL		PARTICULARS		BIDDER/VENDOR						
		NAME								
		SIGNATURE								
		DATE								
LEGEND :		1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB- VENDOR	P - PERFORM	W - WITNESS	BIDDER'S/VENDORS COMPANY SEAL			
							V - VERIFICATION			

		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :							
QUALITY PLAN		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-507-E005, REV.0		SPECIFICATION TITLE:							
SHEET 1 OF 2		SYSTEM CABLING		ITEM : CABLE TRAYS & ACCESSORIES		DOC. NO. :							
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
1.0	RAW MATERIAL												
1.1	ROLLED SHEET	1.CHEM.&PHY. PROPERTIES	MA	VERIFICATION OF TCS	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/ITISCO/IRINJ/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/ LLOYD/ IISCO/ authorised SAIL Re Rollers.	
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-		
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	IS-1079	QC RECORD	3/2	-	-		
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2		
2.0	IN-PROCESS												
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1		
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1		
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-		
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-		
BHEL													
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE										
LEGEND :			1 - BHEL/ CUSTOMER			2 - VENDOR			3 - SUB- VENDOR			P - PERFORMANCE	
												W - WITNESS	
												BIDDERS/VENDORS COMPANY SEAL	
												V - VERIFICATION	

		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :																	
QUALITY PLAN		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-507-E005, REV. 0		SPECIFICATION TITLE:																	
		SYSTEM CABLING		ITEM : CABLE TRAYS & ACCESSORIES		DOC. NO. :																	
SHEET 2 of 2		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS							
1		2		3		4		5		6		7		8		9		10		11			
2.3		GALVANISING		1.TEMPERATURE OF ZINC BATH 2.DROSS 3.RATE OF IMMERSION 4.SURFACE QUALITY		MA MA MA MA		TEMPERATURE INDICATOR VISUAL VISUAL VISUAL		CONTINUOUS PERIODIC 100% 100%		IS-2629 IS 2629 IS 2629/ MFR'S PRACTICE IS 2629		IS-2629 IS 2629 IS2629/ MFR'S PRACTICE FREE FROM BURRS ROUGHNESS, SLAG FLUX, STAIN. ETC.		QC RECORD QC RECORD QC RECORD QC RECORD		2/3 2/3 2/3 2/3		- - 2 -		If vendor doesn't have his own galvanizing plant duly approved by BHEL-PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.	
3.0		FINISHED ITEMS																					
3.1		(CABLE TRAY, ACCESSORIES & HARDWARES)		1.DIMENSIONS 2.SURFACE FINISH		MA MA		MEASUREMENT VISUAL		IS-2500 (PART 1) LEVEL S-4 IS-2500 (PART 1) LEVEL S-4		APPD. DRG APPD. DRG		APPD. DRG FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.		INSP.REPORT INSP.REPORT		2 2		1 1		- - Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet. Following shall be engraved/ punched on each standard length of cable tray at the center of both sides of runner:'PEM' (length of letter 90mm & height 30mm).	
				3.RIGIDITY (FOR TRAYS) 4.MASS OF ZINC COATING 5.UNIFORMITY OF ZINC COATING 6.THICKNESS OF ZINC COATING		MA MA MA MA		DEFLECTION TEST CHEM. TEST CHEM. TEST ELCOMETER		2 No./ LOT/TYPE IS-4759 IS-4759 IS-4759		APPD. DRG IS-6745/ APPD. DATASHEET IS-2633 APPD. DATASHEET		APPD. DRG APPD. DATASHEET IS-2633 APPD. DATASHEET		INSP.REPORT INSP.REPORT INSP.REPORT INSP.REPORT		2 2 2 2		1 1 1 1		- - - - 600MM wide cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.	
		7.ADHESION		MA		MECH.TEST		IS-4759		IS-2629		INSP.REPORT		2		1		-					
		BHEL		PARTICULARS		NAME		SIGNATURE		DATE													
		LEGEND :		1 - BHEL/ CUSTOMER		2 - VENDOR		3 - SUB- VENDOR		P - PERFORM		W - WITNESS		V - VERIFICATION						BIDDERS/VENDORS COMPANY SEAL			

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SECTION – 4

CABLES

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DATASHEET-A2	L.V POWER CABLE
DATASHEET-A3	CONTROL CABLE
DATASHEET-A4	F.S. POWER CABLE
DATASHEET-A5	F.S. CONTROL CABLE
DATASHEET-A6	FLEXIBLE TRAILING CABLE
ANNEXURE-A	CABLE SIZES

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1.0 SCOPE OF SUPPLY

1.1 The cables shall be supplied, installed and commissioned in accordance with the following specification and the details given in data sheets and annexures mentioned below :-

1.1.1 Datasheet – A1 to A6 of section IV Volume IV-B

1.1.2 Annexure-A of section IV of Volume IV-B.

1.1.3 Annexure - D section I of Volume IV-A.

1.1.4 Section IX of Volume IV-B

Other cables including special cables if any which are necessary as per proven engineering practice for satisfactory & trouble free operation of the entire cable system of the power plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

1.2 Cable shall be furnished in accordance with this specification and the following Datasheet-A (A1 to A6)

2.0 CODES & STANDARDS

2.1 All cables and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) ASTM, IEEE, SS, IEC etc. except where modified and/ or supplemented by this specification.

2.2 Cables and material conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.3 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

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3.0 DESIGN CRITERIA

- 3.1 Cables will be generally laid on ladder type trays, perforated type cable trays or drawn through rigid steel conduits.
- 3.2 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification which one is more stringent.
- 3.3 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.
- 3.4 Armouring shall be single round wire of galvanized steel for multicore cables and aluminum for single core cable for power and control cables. For fire survival control cable, the armouring over inner sheath shall consist of single layer of wire / round galvanized steel wire as per IS 3975 amended upto date. For Fire survival power cable, Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire, for multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.
- 3.5 The inner & outer sheath shall have flame retardant low smoke halogen evolution (FRLSH) characteristics or fire survival characteristics as applicable and shall meet the requirements of additional tests specified for the purpose.
- 3.6 Core identification for multicore cable shall be provided by colour coding.
- 3.7 HT cables shall be manufactured by triple extrusion dry cured (CCV) process using pressurized nitrogen.

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4.0	<u>SPECIFIC REQUIREMENTS</u>	
4.1	<u>GENERAL DESCRIPTION</u>	
	All Cables shall be furnished in strict compliance with ratings and requirements and sizes as given in Datasheet-A & Annexures to this Specification.	
4.2	<u>DRUM LENGTH AND TOLERANCE</u>	
	The 11kV & 3.3kV power cables shall be supplied on steel drums. Wooden drums shall be used for 1100V power and control cables. Each drum shall containing minimum 500 meters single length for larger sizes of cable unless specifically asked for. For smaller sizes of cables, each drum shall contain minimum 1000 meters single length of cable. Allowable tolerance on individual drum length is $\pm 5\%$. Empty Steel drums except mandatory spare cables shall be returnable and wooden drums shall be non returnable.	
4.3	<u>NON-STANDARD LENGTH</u>	
	Owner/Purchaser may accept total non-standard lengths upto 5% of the total ordered quantity. However the Contractor will be required to obtain Owner's/ Purchaser's approval before packing the Cables on drums. Non-standard lengths shall not be less than 100 metres in any case.	
4.4	<u>CABLE IDENTIFICATION</u>	
	Cable identification shall be provided by embossing on every meter on the outer sheath with the following details: (a) MSPGCL (b) Manufacturer's name or trade mark (c) Voltage grade (d) Year of manufacture	

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	(e) Type of insulation, e.g. XLPE/PVC/HR85 /IE2 etc. (f) No. of core and size of cables. (g) Type of improved fire performance, e.g. FR/FR-LSH/FS (h) IS number (i) ISI mark Note: Non erasable sequential cable length marking at an interval of 1 (one) meter throughout the Drum length, shall be provided on all cables 4.5 <u>PACKING</u> Cables shall be supplied on drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden cable drum shall be treated by immersing in copper-nitrate solution. Drum number shall be indicated on each cable drum. 4.5.1 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat Shrinkable seal shall be used for this cable ends. 4.5.2 The cable drums should carry the following details in printed form: (a) MSPGCL (b) Manufacturer's name or trade make (c) Type of cable & voltage grade (d) Year of manufacture (e) Type of insulation e.g. XLPE/HRPVC/IE2	

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(f) No. of core and size of cables (g) Cable code e.g. FRLS/FS (h) Single length of cable on drum (i) Direction of rotation, by arrow (j) Approx. gross mass. (k) IS/IEC number and ISI mark		
4.5.3	Joints and Terminations Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements. Straight through joints and terminations for HT cables shall be heat shrinkable type.	
4.6	<u>SELECTION CRITERIA</u>	
4.6.1	(a) HT and LT power cables shall be selected on the basis of current carrying capacity, short circuit current rating and permissible voltage drop. The fault level, refer Design Data Volume IV-A General Electrical Description. (b) Cables from PCC to MCC/ACDB shall be sized for selected busbar rating of MCC/ACDB and steady state voltage drop shall be calculated with selected busbar rating. (c) While sizing power cables, following derating aspects shall be reckoned:	

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(i) Ground/ Ambient Air temperature (ii) Depth of Laying. (iii) Power Cables touching each other. (d) Cables, for circuit breaker controlled outgoing feeders for motors and transformer shall withstand the short circuit current for the fault clearing time of 0.2 Sec. and 1.0 Sec. for tie feeders & Incomers of 11kV, 3.3kV and 415 volt system. Also Outgoing feeders where only IDMT protection is provided 1.0 sec shall be considered as fault clearing time for cable sizing. (e) The Cables shall be capable of continuous satisfactory operation under a power supply system frequency variation of (±) 5%, voltage variation of (±) 10% and combined frequency and voltage variation of ±10% (absolute sum) (f) For fuse protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% at load terminal during running of all feeders and 15 % during starting for motor feeders with rigid coupling. For motors with fluid coupling the starting voltage drop can be considered as 20%. In addition, transformer regulation shall also be considered for loads. (g) For loads fed from local panels, the total running voltage drop in cable from 415V PCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%. (h) Current rating capacity of cables should be 110 % of full load current, after considering the derating factors. (i) For welding receptacle, 3% running drop shall only be considered. The minimum sizes of L.T cable to be chosen are as below: AL - 16 mm² (3 core), Cu - 2.5 mm² (3 core)		

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4.6.2	Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.	
4.6.3	The standard cable sizes, amp capacities, derating factors. as given in IS/IEC will be generally followed.	
4.6.4	(a) For breaker protected circuits minimum size of the cable shall be as follows:	
	1100V Power	: 240 mm ² XLPE
	11000V & 3300 Power	: 240 mm ² XLPE
4.6.5	(b) For motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly following a second hot start.	
	(a) Aluminum : 16 mm ²	
	(b) Copper : 2.5 mm ²	
	(c) Recommended cable sizes for various motor ratings	
	Motor rating	Cable size
	(i) 0-5.5kW	3C-25/4/6/10 mm ² Cu as per voltage drop
	(ii) 5.6-11kW	3C-16 mm ² Al
	(iii) 11.1-22kW	3C-35 mm ² Al
	(iv) 22.1-45kW	3C-95 mm ² Al
	(v) 45.1-75kW	3C-185 mm ² Al
	(vi) 75.1-below 90kW	2x3C-185 mm ² Al

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Note:

220V DC incomer supply to HT & LT switchgear and protection panels minimum size of 220V dc supply F.S cable shall be 10 mm² & 6 mm² respectively.

4.6.6 All control cables shall be 2.5 mm² copper cables.

4.6.7 Multicore control cables will generally have spare conductor (s) in accordance with the following chart :

Conductors required		Cables
(a)	1 or 2	: 1-3/C
(b)	3 or 4	: 1-5/C
(c)	5 or 6	: 1-7/C
(d)	7 or 8	: 1-9/C
(e)	9 or 10	: 1-12/C
(f)	Above 10	: Two or more of above cables

4.6.8 Separate cables for each type of following services/functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.

- (a) Power.
- (b) Control, interlock and indication.
- (c) Metering and measuring.
- (d) Alarm and annunciation.
- (e) C.T. Cables.
- (f) V.T. Cables.

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4.7 Selected sizes of power and control cables are given in Annexure-A. 4.8 Fire Survival Cables shall be used for important auxiliaries / area as recommended by Standard Technical Specification and CEA as below for the following: Fire Survival Power & Control Cables shall be used for important auxiliaries/areas like: (a) DC emergency lube oil pump (b) DC hydrogen seal pump (c) Turbine lube oil pump/barring gear (d) DC emergency lighting for main building and service building (e) DC cables for battery to charger & DC distribution boards, also cables from DCDB to DCFB (f) Jacking oil pump (g) Emergency turbine trip in control room (h) Boiler Turbine: Generator inter trip which include the interconnection between (i) Boiler master fuel trip and turbine trip relays (ii) Generator trip relays & turbine trip relays (iii) Generator trip relays & generator breaker (iv) Generator trip relays & field breaker (v) Generator trip relays & unit auxiliary transformer breaker		

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	(i) Incomer cables for DG board, emergency board, DC lighting board etc. (j) Scanner air fan & fire/smoke detector system (k) Complete 220V DC, 24V DC & UPS control, protection & supply of cables downstream of DCDB/ACDB shall be with minimum cable size of 2Cx6 sqmm Cu	
5.0	<u>TESTS</u>	
5.1	<u>SHOP TESTS</u>	
	The Cables shall be subject to shop tests in accordance relevant IS/IEC/ASTM/IEEE/SS standards and QAP approved by purchaser to prove the design and general qualities of the Cables as below:	
5.1.1	Routine tests shall be carried out on each drum of cables.	
5.1.2	Acceptance Tests shall be carried out on 1 drum out of every 10 or less number drums chosen at random for acceptance of the lot for every type & size of cable.	
5.1.3	Type test as per relevant IS, on each type and size of cable, inclusive of measurement of armour DC resistance of power cables shall be carried out on one sample drum selected on random basis in each lot. Size of cable shall be read in sq. mm. in conjunction with number of cores. Type of cable shall mean voltage grade, XLPE, HRPVC, FRLS, FS etc	
5.2	<u>ADDITIONAL TESTS</u>	
	Following additional Type & acceptance tests shall also be performed on each type of cables having inner & outer sheath with improved fire performance (Type FRLSH, FS). The quantum of check shall be as elaborated above for additional type and acceptance test.	
5.2.1	Oxygen index test The Oxygen index shall not be less than 29.	

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5.2.2	Temperature Index Test The measured value of temperature index shall be 21 at a temperature of 250°C for FRLS cables and 350°C for FS cables	
5.2.3	Flame Retardance test on single cable and on bunched cables After the test, there should be no visible damages on the test specimen within 300mm from its upper end. After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly. 3 Hours fire rating test shall be carried out for FS cable as per IEC331	
5.2.4	Halogen acid gas evolution test The level of HCL evolved shall not exceed 20 per cent by weight. HCL evolved shall not exceed 2% for FS cable.	
5.2.5	Smoke density test The cables shall meet the requirements of light transmission of minimum 40% after the test. Minimum transmission shall be 80% for FS cable.	
5.2.6	Test for specific optical density of smoke The cables shall meet the requirements of IS/IEC.	
5.2.7	Test for rodent & termite repulsion property	
5.2.8	The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to	

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soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound. 5.2.9 Flammability test shall be carried on finished cables as per following standards: (a) Swedish Chimney test – SS:424-14-75 (b) IEEE std.383 – 1974 latest (c) IEC std. 332-1 and IEC 331 5.3 <u>TEST WITNESS</u> Tests shall be performed in presence of Owner/Purchaser's representative. The Contractor shall give at least fifteen (15) days advance notice of the date on which the tests are to be carried out. 5.4 <u>TEST CERTIFICATES</u> 5.4.1 Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner/Purchaser. 5.4.2 Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review. 5.4.3 The cables shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.		

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<u>H.V. POWER CABLE</u> <u>DATA SHEET – A1</u>		
<u>SR. NO.</u>	<u>ITEM</u>	
1.0	<u>11 kV & 3.3 kV POWER CABLE</u>	
1.1	11kV & 3.8/6.6kV grade 90° C continuous rating under normal condition and 250° C rating under short circuit condition heavy duty XLPE power cable suitable for use in 11kV & 3.3kV non-effectively earthed (UE) system conforming to following requirement and in line with IS-7098, IS-8130, IS-5831 & IS-3975, manufactured by Triple Extrusion Dry Cure(CCV) process using pressurized Nitrogen	
1.1.1	Conductor	Stranded and compacted circular aluminium conductor of grade H2 & class 2 for all sizes, generally conforming to IS:8130
1.1.2	Conductor Screen	Extruded semi-conducting compound
1.1.3	Insulation	Extruded cross linked polyethylene (XLPE) conforming to IS7098 (Part-2)
1.1.4	Insulation Screen	Extruded semi-conducting compound in combination with a layer of lapped copper tape of thickness is not less than 0.1mm.
1.1.5	Core Identification	By coloured strips applied on (For three core cables) cores or by numerals.

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<u>SR. NO.</u>	<u>ITEM</u>		
1.1.6	Inner Sheath		Extruded HRPVC/FRLS compound conforming to type ST2 of IS: 5831 for three core cables. Single core cables shall also have inner sheath. Filler material shall also be of type ST2 PVC.
1.1.7	Armour		Galvanised single round steel wire armour for twin and multicore cables
			Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables.
1.1.8	Overall Sheath		Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.1.9	Drum		Steel Drum

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<u>L.V. POWER CABLE (XLPE TYPE)</u> <u>DATA SHEET – A2</u>		
<u>SR. NO.</u>	<u>ITEM</u>	
1.0	<u>415V LT POWER CABLES</u>	
1.1	Rating: 1.1 kV grade, 90° C continuous rating under normal condition and 250°C under short circuit condition rating, XLPE heavy duty, power cable conforming to following requirement and in line with IS 7098 Part-I. IS 8130 & IS 5831 and IS 3975.	
1.1.1	Conductor	Stranded and compacted plain aluminium of grade H2 and stranded, high conductivity annealed plain copper as applicable conforming to IS:8130. Class 2
1.1.2	Insulation	Extruded cross-linked polyethelene (XLPE) conforming to IS:7098 (Part-1)
1.1.3	Core Identification	By color-coding.
1.1.4	Inner Sheath	Extruded HRPVC FRLS compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2
1.1.5	Armour	Galvanized single round steel wire armour for twin and multicore cables.

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<u>SR. NO.</u>	<u>ITEM</u>		
1.1.6			Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables.
1.1.7	Overall Sheath		Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.1.8	Drum		Conforming to IS-10418 (Wooden drum)

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<u>CONTROL CABLE</u> <u>DATA SHEET – A3</u>			
<u>SR. NO.</u>	<u>ITEM</u>		
1.0	<u>CONTROL CABLES</u>		
1.1	Rating : 1.1kV grade 85° C continuous rating under normal condition and 160°C under short circuit condition rating HRPVC Control cable (YWY) conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.		
1.1.1	Conductor		Stranded, non-compacted & circular, high conductivity annealed plain copper, generally conforming to IS: 8130.
1.1.2	Insulation		Extruded HRPVC type-C compound conforming to IS: 5831. The minimum volume resistivity of insulation shall be 3.5×10^{14} ohm-cm at 27°C and 3.5×10^{11} OHM-CM at 85°C.
1.1.3	Core Identification		By color coding and numbering at interval of 100mm or less.
1.1.4	Inner Sheath		Extruded HRPVC compound conforming to type ST2 FRLS of IS: 5831 for multicore cables. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2.
1.1.5	Armour		Galvanised single round steel wire for twin and multicore cables.

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<u>SR. NO.</u>	<u>ITEM</u>		
1.1.6	Overall Sheath		Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.1.7	Drum		Conforming to IS: 10418 (Wooden drum).

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1.1 K V GRADE COPPER CONDUCTOR FIRE SURVIVAL POWER CABLE

DATA SHEET – A4

<u>SR. NO.</u>	<u>ITEM</u>		
1.0	These cables shall be 90 deg C rating under normal condition and 250 deg C under short circuit condition generally confirmed to IS 9968 Part I latest with 3 hr fire rating		
1.1	Conductor		Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130. A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor
1.2	Insulation		The insulation shall consist of heat resisting electrometric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS: 6380 / 1984 amended up to date.

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<u>SR. NO.</u>	<u>ITEM</u>		
1.3	Laying up of cores (For multicore cables only)		The core shall be suitably identified in accordance with IS: 9968 (Part-I). The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fibre binder tape shall be applied over the laid up cores.
1.4	Inner Sheath		An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS – 6380/1984, ammended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fibre tape over the insulation.

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<u>SR. NO.</u>	<u>ITEM</u>	
1.5	Armour	For Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire. For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanised steel wire.
1.6	Overall Sheath	The extruded outer sheath shall be of special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS:6380 latest revision. Minimum value of 'Tensile Strength' and 'Percentage elongation at rupture' shall be 8 Newton/sq.mm. and 250% respectively. The colour of outer sheath shall be black or any other colour agreed mutually between Owner & supplier.

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1.1 kV GRADE COPPER CONDUCTOR FIRE SURVIVAL CONTROL CABLE

DATA SHEET – A5

<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
1.0	These cables shall be 90 deg C rating under normal condition and 250 deg C under short circuit condition generally confirmed to IS 9968 Part I latest with 3 hr fire rating		
1.1	Conductor		It shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS: 8130 / 1984 amended upto date. A suitable heat barrier tape, preferably glass mica tape shall be provided over conductor.
1.2	Insulation		The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethelene Propylene rubber) and shall conform to type IE-2 of IS 6380/1984 latest revision.

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
1.3	Laying up of cores (For multicore cables only)		The core shall be suitably identified in accordance with IS:9968 (Part-I) The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fiber binder tape shall be applied over the laid up cores.
1.4	Inner Sheath		An inner sheath of extruded very low halogen (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE3 of IS 6380 / 1984 amended upto date shall be provided over the laid up cores.
1.5	Armour		The armouring over inner sheath shall consist of single layer of wire / round galvanised steel wire as per IS 3975 amended upto date.

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<u>SR. NO.</u>	<u>ITEM</u>	<u>UNIT</u>	
1.6	Overall Sheath		The outer sheath shall be of special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision. The colour of outer sheath shall be black or any other natural colour with prior approval of the Owner.

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FLEXIBLE TRAILING CABLE

DATA SHEET – A6

<u>SR. NO.</u>	<u>ITEM</u>		
1.1	3300V Unearthed Grade		Flexible trailing cable, annealed plain copper conductor, Class-5 of IS-8130, insulated with EPR, conductor and Insulation shielded with EPR, cores screened with ATC wire braiding, cores laid up, HD CSP inner sheathed, proof cotton taped and FRLSH HD CSP sheathed overall, confirming to IS:9968. Alternatively PCP sheathing may be acceptable.
1.2	1100V Grade		1100V Grade trailing cable shall be plain copper of Class-5 of IS-8130, heat resistant elastomeric compound based on EPR insulation, inner sheath of heat resistant elastomeric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty elastomeric compound FRLSH CSP outer sheath.

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CABLE SIZES

ANNEXURE – A

<u>SR. NO.</u>	<u>CABLE SIZE</u>	<u>CONDUCTOR</u>	<u>INSULATION</u>
1.0	<u>H. V. CABLES</u>		
1.1	1 core 630 Sq.mm	Al.	XLPE (FRLSH)
1.2	1 core 500 Sq.mm	Al.	XLPE (FRLSH)
1.3	3 core 240 Sq.mm	Al.	XLPE (FRLSH)
1.4	3 core 300 Sq.mm	Al.	XLPE (FRLSH)
1.5	1 core 70 Sq.mm	Al.	XLPE (FRLSH)
2.0	<u>L. V. POWER CABLES</u>		
2.1	3 core 2.5/4/6/10 Sq.mm	Cu.	XLPE (FRLSH)
2.2	2 core 16 Sq.mm	Al.	XLPE (FRLSH)
2.3	3 core 16 Sq.mm	Al.	XLPE (FRLSH)
2.4	4 core 16 Sq.mm	Al.	XLPE (FRLSH)
2.5	2 core 35 Sq.mm	Al.	XLPE (FRLSH)
2.6	3 core 35 Sq.mm	Al.	XLPE (FRLSH)
2.7	4 core 35 Sq.mm	Al.	XLPE (FRLSH)
2.8	3 core 95 Sq.mm	Al.	XLPE (FRLSH)
2.9	3.1/2 core 95 Sq.mm	Al.	XLPE (FRLSH)
2.10	3 core 185 Sq.mm	Al.	XLPE (FRLSH)
2.11	3.1/2 core 185 Sq.mm	Al.	XLPE (FRLSH)

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<u>SR. NO.</u>	<u>CABLE SIZE</u>	<u>CONDUCTOR</u>	<u>INSULATION</u>
2.12	3 core 240 Sq.mm	Al.	XLPE (FRLSH)
2.13	3.1/2 core 240 Sq.mm	Al.	XLPE (FRLSH)
2.14	3 core 300 Sq.mm	Al.	XLPE (FRLSH)
2.15	3.1/2 core 300 Sq.mm	Al.	XLPE (FRLS)H
2.16	1 core 630 Sq.mm	Al.	XLPE (FRLSH)
3.0	<u>CONTROL CABLE</u>		
3.1	2 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.2	3 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.3	5 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.4	7 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.5	9 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.6	12 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
3.7	20 core 2.5 Sq.mm	Cu.	HRPVC (FRLSH)
4.0	<u>FS POWER CABLES</u>		
4.1	3 core 2.5 Sq.mm	Cu.	EPR
4.2	4 core 2.5 Sq.mm	Cu.	EPR
4.3	2 core 6 Sq.mm	Cu.	EPR
4.4	2 core 16 Sq.mm	Cu.	EPR
4.5	3 core 16 Sq.mm	Cu.	EPR
4.6	4 core 16 Sq.mm	Cu.	EPR
4.7	2 core 35 Sq.mm	Cu.	EPR

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<u>SR. NO.</u>	<u>CABLE SIZE</u>	<u>CONDUCTOR</u>	<u>INSULATION</u>
4.8	3 core 35 Sq.mm	Cu.	EPR
4.9	4 core 35 Sq.mm	Cu.	EPR
4.10	3 core 95 Sq.mm	Cu.	EPR
4.11	3.1/2 core 95 Sq.mm	Cu.	EPR
4.12	1 core 630 Sq.mm	Cu.	EPR
5.0	<u>FS CONTROL CABLE</u>		
5.1	2 core 2.5 Sq.mm	Cu.	EPR
5.2	2 core 6 Sq.mm	Cu.	EPR
5.3	3 core 2.5 Sq.mm	Cu.	EPR
5.4	5 core 2.5 Sq.mm	Cu.	EPR
5.5	6 core 2.5 Sq.mm	Cu.	EPR
5.6	7 core 2.5 Sq.mm	Cu.	EPR
5.7	9 core 2.5 Sq.mm	Cu.	EPR
5.8	10 core 2.5 Sq.mm	Cu.	EPR
5.9	12 core 2.5 Sq.mm	Cu.	EPR
5.10	16 core 2.5 Sq.mm	Cu.	EPR

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VOLUME IV-B

SECTION – 10

INSTALLATION OF CABLING, GROUNDING AND

LIGHTNING PROTECTION SYSTEM

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1.0 SCOPE OF WORK

1.1 The scope of work covers Supply, Erection, Testing and Commissioning of complete Electrical system including cabling, grounding & lightning protection system, Fire Stop mortar seal, fire retardant cable coating system etc. The scope shall broadly cover, but not be limited to:

- (a) Main Power House Building.
- (b) Boiler area, ESP.
- (c) Transformer yard.
- (d) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the General Electrical Specification/plot plan/ & related drawings.
- (e) Coal Handling Plant
- (f) Ash Handling Plant Including Ash Dyke
- (g) Raw Water System Including outside raw water pump house.
- (h) Stack including during construction lightning & grounding protection
- (i) Fuel Oil Unloading & Transfer system
- (j) Aux. Power Transformers
- (k) Pipe cum cable rack.
- (l) All electrical equipment as described in different sections.
- (m) As built drawing for all above systems on completion of project.

The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

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2.0 SCOPE OF SUPPLY

2.1 The scope of supply shall include but not be limited to the followings:

2.1.1 Timely procurement and transportation to site, unloading, storing at site in properly packed condition of all materials and miscellaneous items required to complete the erection work under this specification.

These materials and miscellaneous items shall include but not be limited to the following:

- (a) Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.
- (b) Galvanized steel rigid/flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc. as required.
- (c) Cable termination and jointing kits as necessary.
- (d) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.
- (e) Mild steel rods, galvanized steel flats, galvanized steel rods, lead coated copper tube suitably brazed with galvanized steel Bend ring galvanized steel wires etc. required for grounding and lightning protection system shall be supplied in standard lengths.
- (f) Fire Stop mortal seal and fire retardant cable coating system.
- (g) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the Purchaser.

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(h) HT, LT power and control cables, FS cables, FO cables & any special cables, instrumentation cables for electrical equipments as per Clause No.1 of Section IV of Volume IV-B. 2.1.2 (a) Main Ground Mat Ground mat (Grid) shall be provided in power block (BTG) area, transformer yards & below all HT & LT switchgears as per details given in following sections. Laying of underground conductors and arc welding of the conductors at each crossing and straight run (lap joint) shall be provided. The conductors at the periphery of the mat shall be 1 no. 40 mm (min) diameter M.S. rod and the internal cross conductors of the mat shall be 1 No. 40 mm (min) diameter M.S. rod. Suitable pigtails shall be provided and shown in the layout drawing for connection with other plant/ground grids, stack, other grounding systems in power plant area / & switchyard etc. (b) Grounding Electrode Fabrication and driving into ground 40 mm (min) diameter 3000 mm long M.S. rod and connecting them to the grounding mat by arc welding. 100 N.B. CI pipes for system Neutral earthing. (c) Column Grounding (i) Concrete Columns Erection of 1 no. 40 mm (min) dia. M.S. rod from grounding mat to all concrete columns including necessary fixing, welding of one end of the rod with ground mat and the other end with the column above ground by welding with a short GS flat to edge angles. (ii) Steel Columns Erection and connection of 1 No. 40 mm (min) diameter M.S. rod from grounding mat to all steel columns including necessary fixing welding with ground mat and the other end with the column above ground with a short GS flat.		

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(d) Risers Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Each riser will be 1 No. 40 mm (min) dia. M.S. rod and Minimum 300 mm above grade level/concrete floor level. (e) All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification. (f) Perimeter Grounding: Perimeter grounding shall be provided for all areas of outdoor plant & buildings & interconnection between each outdoor plant & buildings ground subgrid and power block (BTG) ground grid shall be done at atleast four points. Each outdoor plant & buildings subgrid shall also be interconnected with each other at atleast 4 points by EPC vendor. (g) Earth electrode shall be provided at each corner of the perimeter grounding system. The ground resistance of perimeter grounding system shall be less than 0.5Ω (h) Lightning protection system Note: Minimum size of the MS rod used for the earth mat, riser and grounding electrode shall be 40 mm dia. 2.2 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make. 2.3 Material for electronics earthing system (electronics earth electrode, earthing bus and single core copper cable from earth pit to electronic earthing bus) shall be of hard drawn copper wire as per equipment vendor suppliers requirement.		

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	Connection from electronic earth bus to individual equipment shall be with minimum 6 sq. mm. copper cable or equipment supplier recommendation whichever is higher. 2.4 Power plant EPC vendor shall be responsible for taking power from these feeders including supplying, laying and termination of all power, Control cables and instrumentation cables including cabling system where necessary within power plant area. Cable trays shall be provided upto battery limit of power plant area including Power House by power plant EPC vendor .(Ref: Annexure-D, Volume IV-A). 2.5 Necessary drawings, data sheets and Technical leaflets on each piece of material. 2.6 <u>SCOPE OF SERVICES</u> The scope includes but is not limited to the followings: 2.6.1 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work. 2.6.2 The items of erection work shall be performed with respect to the following equipment/materials: (a) Cabling of Power Cables (b) Cabling of Control, instrument and special cables (c) Entire cable tray and cable shaft arrangements inside Power House & other areas including outdoor cable bridges, trestles and all associated civil and structural works including foundation and cable trenches. (d) Supply and Erection of Grounding system. (e) Supply and Erection of lightning Protection System. (f) Fire Stop mortal seal, fire retardant cable coating system. Note: - Cables directly laid or buried in ground is not accepted.	

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3.0 <u>GENERAL REQUIREMENTS</u> 3.1 <u>CODES AND STANDARDS</u> 3.1.1 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/ or supplemented by this specification. 3.1.2 Cable and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid. 3.1.3 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed. 3.2 <u>ERECTION SCHEDULE</u> 3.2.1 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the Bidder for this purpose. 3.2.2 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay. 4.0 <u>DESIGN CRITERIA</u> 4.1 <u>GROUNDING SYSTEM</u> 4.1.1 Design basis The power plant grounding system shall be symmetrical ground grid / symmetrical earth mat with equal spacing of grounding conductor designed in compliance with IEEE 80 and IEEE665 considering fault current of 50kA for 1 sec and shall be subject to approval of owner after submission of manual design calculation with following parameters & clauses.		

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Soil resistivity -120 Ohm-meter Surface resistivity -1000 Ohm-meter Fault duration -1sec and shock duration 1sec weight of person-50kg depth of buried earth grid conductor-1000mm Earth resistance value shall be less than 0.5ohm for earthing system. 4.1.2 Grounding shall follow the relevant standards/codes amended till date as below: (a) Indian Electricity rules (b) National Electrical Code (c) Code of Practice of Earthing IS 3043 (d) Protection of building and allied structures against lightning IS 2309. (e) IS- 732, IS 226, IS 2629, IS 2633 & IS 4759 (f) IEEE -80, IEEE-665 The station grounding system shall be an interconnected network of MS conductor and MS ground rods. The system shall be provided to protect plant personnel and equipment from the hazards, which can occur during power system faults and lightning strikes However, the surface resistivity shall be considered as 1000-ohm meter. (a) Major items of equipment, such as generator, switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the station ground grid. (b) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation transformers shall be furnished. All indoor and outdoor electrical		

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	equipment and associated non current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system. (c) Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference. (d) For Signal /case / intrinsically safe signal, grounding of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit. (e) A grounding conductor (steel wire armor) shall be routed parallel to all power conductors operating above 240 volts. (f) All ground wires installed in conduits shall be uninsulated. (g) Embedded grounding grid of 75x10mm GS flat at basement/grade slab as well as upper floor/suspended slabs shall be provided. (h) For every upper/lower floor grounding grid the distance between two adjacent risers originating from below the ground grounding grid shall not be greater than 10meters. (i) In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two 75x10mm GS flats. (j) Treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two pits shall be provided for each neutral. (k) Dedicated treated earth pit shall be provided for lightning protection system.	

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(l) Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits below the main control room, feed water pump house in turbine house etc. (m) The necessary arrangement & system for watering of all the transformer neutral earth pits is to be provided. 4.1.3 In order to meet the above objectives, symmetrical ground grid mesh will be provided as specified. Interconnection between switchyard ground grid and power plant ground grid shall be done atleast four points and responsibility lies on power plant EPC vendor. All electrical equipment, non current carrying metal parts, structures, building steel, lightning protection system, generator / transformer neutrals will be connected to this station ground grid. The major aspects to be considered for grounding system design are given below 4.1.4 Ground Grid Conductor (a) Ground grid conductor of mild steel rod shall be used. (b) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm per year over the design life of 30 years. 4.1.5 Underground Grid (a) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE 665 and Touch voltage and step voltage is to be calculated considering weight of person 50kg. (b) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than one (1) ohm.		

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(c) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment. (d) Ground rods shall be provided at the points where lightning protections are connected to the ground grid. (e) All ground grid conductor connections will be welded type. (f) For test pits, the Electrode will be 100 mm dia. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities 4.1.6 Above Ground Connections (a) Galvanized steel flats shall be used for all connections above earth. (b) Inside building, ground conductors 75x10 mm will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (riser raised for each alternate column or 10 meter distance between riser, whichever is higher) coming up along building columns / cable shafts. (c) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules. (d) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type. 4.1.7 Equipment Ground Connection Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes. 4.1.8 The minimum ground conductor sizes for various equipment and structures are given in Annexure-B.		

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4.1.9	Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation. 4.2 <u>LIGHTNING PROTECTION SYSTEM</u> Lighting protection system design shall be as per IS: 2309 4.2.1 The main purposes of lightning protection system are to: (a) Provide protection to structures from lightning strokes. (b) Provide a low resistance-conducting path to lightning discharge. 4.2.2 Lightning protection shall be provided for Power House building, Mill building & Transformer yard. 4.2.3 Lightning protection shall be provided for structures/building higher than 55 meters in and/or where the calculated risk index exceeds 10^{-5} 4.2.4 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections. 4.2.5 System Design (a) Air termination network with down conductors and earthing electrodes will be provided on the basis of IS Code of Practice. (b) The spacing between two horizontal air termination shall not exceed 10 meters (c) The vertical air terminal rods shall be installed at the roof of buildings (including power house building), to protect these objects from lightning strokes.	

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	(d) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees. (e) Down conductors will run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground. (f) An earth electrode will be provided at the connection point of the down conductor with the station ground (g) Galvanized steel rods and flats will be generally used for air termination and connections. All connections will be welded type.	
4.3	<u>CABLING SYSTEM</u>	
4.3.1	Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all station auxiliaries.	
4.3.2	Cables will generally be laid on cable trays, cable rack, overhead supported from building steel/structures or cable bridge/cable trestle. Cables shall be run in concrete trenches only in transformer yard, concrete trenches is not accepted for other areas/ buildings. Cables buried directly in ground are not acceptable. For indoor pumps, mechanical equipment areas overhead cable trays shall generally be used.	
4.3.3	For underground crossing of railways, road etc. additional protection shall be provided in form of Hume pipe or concrete encased rigid steel conduits (duct bank).	
4.3.4	A.C. and D.C. circuit will not be run in same cable trays. Further, separately fused circuit will run in separate cable trays.	
4.3.5	Cables for redundant equipment system shall be run in separate trays.	
4.3.6	Control and instrumentation cables shall be run in separate perforated cable trays only.	

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4.3.7 4.3.8 4.4 5.0 5.1 5.1.1 5.1.2 5.1.3 5.1.4	Erection of cabling work shall be executed keeping in view all necessities and requirements of fire fighting codes for Generating Stations having an adverse industrial environment. Vertical run Cable Tray arrangement shall be adopted in dust ingested areas like Boiler, ESP, CHP, AHP etc. Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays such as on Boiler platforms in addition to normal tray cable loadings. All cabling work to be carried out under this specification shall conform to the notes and details given in Annexure-A to this section. <u>SPECIFIC REQUIREMENTS – SUPPLY</u> <u>EQUIPMENT AND MATERIAL</u> Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and Annexures, including typical erection sketches and data sheets for various systems covered in Bidders scope. Equipment and materials furnished shall be complete and operative in all details. All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished. All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.	

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5.2 PRE-FABRICATED CABLE TRAYS

- 5.2.1 Cable trays shall be pre-fabricated ladder type, perforated type cable trays sheet steel with hot dip galvanizing furnished in standard length of 2.5 metres.
In areas, where acid/alkali ingration is likely to occur, glass reinforced plastic trays with fire retardant corrosion resistance properties shall be used.
- 5.2.2 Cable trays shall be of standard width specified in Annexure-A.
- 5.2.3 Cable trays shall be complete with all necessary hot dip galvanized sheet steel accessories such as coupler plates, ground continuity connections, nuts, bolts, washers, hangers, clamps etc. Also horizontal/vertical bends, horizontal / vertical Tee, Reducers, Horizontal cross-pieces, protective covers shall be supplied along with straight runs in order to take care of cable tray alignments in different routes.
- 5.2.4 All fittings like horizontal/vertical elbow, horizontal crosspiece, reducer, horizontal tee etc. should be prefabricated.
- 5.2.5 Cable trays, fittings & accessories as well as elbows, reducers, tees, crosses etc. shall be fabricated out of 14 gauge (2 mm thick) hot rolled mild steel sheets.
- 5.2.6 Contractor shall supply 14 gauge (2 mm thick) perforated type hot rolled mild steel sheet covers for vertical cable shafts up to a height of 2.5 metres from floor level. The perforated covers used for the vertical raceways may be of one or more pieces along the width of the raceway, depending on the width of the raceway and shall be bolted to the structural framework of the raceway.
- 5.2.7 The cable trays, fittings and accessories including all bolts, nuts, screws, washers etc. shall be hot dip galvanized after fabrication as per IS:2629. Galvanizing shall be uniform, clear, smooth and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel will have to be regularized at Contractor's cost.

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The amount of zinc deposited shall not be less than 610 gms per square metre of surface area and in addition the thickness of the zinc deposit at any spot whatsoever, shall not be less than 86 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elcometer or any other instrument and reject any component, which shows thickness of zinc at any location to be less than 86 microns. 5.2.8 Each 2.5 meter long section of all types of cable trays & each fittings like elbow, tees, crosses etc. shall be provided with 2 (two) nos. hot dip galvanized side coupler plates & associated bolts, nuts and washers on each side. 5.2.9 The Contractor shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and that such tests are adequate to demonstrate that the equipment will comply with the requirement of this specification. The tolerance on dimensions shall be in accordance with appropriate Indian Standards. The extent of the tests to be performed by the contractor in presence of owner shall include but not be limited to the following: Deflection Test: A 2.5 meter straight section of each type of cable trays shall be simply supported at the two ends. A uniformly distributed load of 100 Kg per meter will be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7 mm. All the tests shall be carried out as per relevant standards & approved QAP. 5.2.10 For other details refer CABLING NOTES AND DETAILS annexed to this specification. 5.3 <u>CONDUITS AND ACCESSORIES</u> 5.3.1 Conduits shall be of rigid steel, hot-dip galvanized, furnished in standard length of 5 metres, threaded at both ends		

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5.3.2	Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm. 5.3.3 Each piece of conduit shall be straight, free from blister and other defects, internal surface shall be of smooth finish and covered with capped bushings at both ends. 5.3.4 The contractor shall provide and install all rigid steel conduits, mild steel pipes, flexible conduits rigid PVC pipes etc. complete with accessories such as tees, bends, adapters, locknuts, pull boxes, conduit plugs, caps etc as required for the cabling work. 5.3.5 Steel conduits with interior coating of silicon epoxy ester for ease of wire/cable pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanized. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS: 9537. In chemical handling areas, Battery Room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. HDPE conduits shall be used for these areas. Conduits, fittings & accessories shall have ISI mark. 5.3.6 For sizes above 63 mm mild steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. Pipes shall be manufactured by electric welding process. These pipes shall be of heavy duty class as per IS:1239 and shall have ISI mark. Pipes shall be supplied in lengths of approximately 5 metres. Pipes, fittings & accessories shall be hot dip galvanised both on inside and outside. 5.3.7 Flexible conduits shall comply with IS:3480. They shall be made with bright, cold-rolled, annealed and electro-galvanised mild steel strips. Flexible conduits shall be used between embedded conduits/pipes and the motor terminals. Flexible conduits shall also be used between fixed conduit and any equipment terminal boxes where vibration is anticipated or equipment that require regular removal. 5.3.8 Rigid PVC conduits conforming to IS:4985 shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and	

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where the runs are straight ones generally the PVC pipes with special Bell Mouthing shall be of 110 mm, 160 mm & 200 mm outside diameter and shall be suitable for working pressure of 6 kg/sq. cm. The length of each pipe shall be 5 to 6 metres. Necessary fittings & accessories as may be required for the installation shall also be provided. 5.4 <u>JUNCTION BOXES</u> 5.4.1 Glass Fibre Reinforced Junction Boxes (For outdoor use) 5.4.1.1 No. of Ways: 12 / 24 / 36 / 48 with 20% spare terminals. 5.4.1.2 Design Junction boxes shall be Glass Fibre Reinforced with saturated polyester informing to standards like DIN 16911 type 803 / 16913 type 834, 5 self extinguishing in accordance with ASTM D 635 / UL 94 VO. Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50 014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 kV / mm, halogen free toxicity, the enclosure and door cover shall be painted and electrostatically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door. Doors: With integrated viewing window of 3 mm resistant plexi – glass or equivalent. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener. (a) Protection Class Protection Category shall be IP 66 to EN60 529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane / chloroprene. The sealing rubber shall not have		

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aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred). (b) Mounting clamps and accessories Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plants etc. of steel shall be powdered coated. The support rails for terminal box shall be zinc coated (c) General (i) JBs shall have small canopy at the top. (ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside. (iii) Cable entry shall be from bottom side only. (iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement. 5.4.2 Steel Junction Boxes :(For indoor use) (a) No. of Ways: 12 / 24 / 36 / 48 with 20% spare terminals. (b) Design Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18, 20 or equivalent standards. (c) Enclosure Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be		

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	surface finished clean, degreased, fospheted, deep coated primed (preferably in RAL 7044) and electrostatically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door. The sheath steel thickness shall be minimum 2 mm. (d) Doors The doors shall be hinged and lockable. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener. (e) Protection Class Protection Category shall be IP 66 to EN60 529 / 10.91 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred). (f) Mounting clamps and accessories: Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. General: (i) JBs shall have small canopy at the top.	

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	(ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside. (iii) Cable entry shall be from bottom side only. (iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.	
5.5	<u>TERMINALS</u>	
5.5.1	Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.	
5.5.2	Each control cable terminal shall be suitable for connection of 2 nos. 2.5 mm ² stranded copper conductors without any damage to the conductor or looseness of conductors.	
5.6	<u>CABLE TERMINATION & JOINTING KITS</u>	
5.6.1	The Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables etc. along with all accessories & consumables required for making termination and joints complete. All the materials and components of the termination/joints shall be suitable and compatible with the type of cables for which the terminals/joints are intended	
5.6.2	For HT cables, the end terminations & jointing kits shall be of heat shrinkable type of Raychem, REPL, CCI or of approved make. For LT cables, the jointing kits & termination kits shall be Raychem/REPL/CCI/ Mahindra (M-seal) or of approved make. Cable joint or end terminations on Electrical equipment shall be suitable for Indoor & Outdoor use, as the case may be.	
5.6.3	Glands and lugs required for termination of H.T., L.T. and instrumentation cables shall be supplied by the Contractor in required quantity.	

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5.7 CABLE GLANDS

Cable glands shall be nickel plated gland, double compression type complete with necessary armour clamp and tapered washer etc. Cable glands shall match with the sizes of different HT/LT/Control cables.

5.8 CABLE LUGS

All cable lugs shall be Cd plated copper. Cable lugs shall be suitable for termination of different cross-sections of H.T./ L.T./ Control/ Instrumentation cables and shall be of following types:

- (a) Aluminium tubular terminal end for solder less crimping to aluminium conductors.
- (b) Copper tubular terminal end for solder less crimping to copper conductors.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/ instrumentation cables shall be PVC insulated/sleeved type.

- (c) Cable lugs for control cable termination shall be insulated. These lugs shall be flat type/ring type/U type to suit the terminals provided in the panels.

5.9 CONSUMABLES AND HARDWARE

5.9.1 The Contractor shall furnish all erection materials, hardware and consumables required to complete the installation.

5.9.2 The materials shall include but not be limited to the following :

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

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	Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.	
5.9.3	Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.	
5.10	<u>TESTING EQUIPMENT</u>	
5.10.1	The major testing equipment that are required to be provided by the Contractor are listed below:	
	(a) Insulation Tests (i) Power operated Meggar - 1 kV and 10kV grade (ii) Hand operated Meggar - 1 kV grade (b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms. (c) High potential testing set - roller mounted type. (d) Tong testers of suitable ranges. (e) Contact resistance measuring set for micro-ohms. (f) Torque wrench of various sizes. (g) Multi meters, test lamp, field telephone with buzzer set, different gauges etc.	
5.10.2	The list of equipment is indicative only. Any other test equipments required will be arranged by the Contractor.	
6.0	<u>METHODS AND WORKMANSHIP</u>	
6.1	All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.	

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6.2	The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.	
6.3	All details on installation shall be electrically and mechanically correct.	
6.4	The installation shall be carried out in such a manner as to preserve access to other equipment installed.	
7.0	<u>INSTALLATION</u>	
7.1.1	Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.	
7.1.2	Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.	
7.1.3	Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables on trays inside trenches tunnels/overhead trays in conduits etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/termination kits, lugs, glands, ferrules, tapes etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.	
7.1.4	Grounding installation work shall mean erection, jointing/ brazing/welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.	
7.1.5	Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors etc. of lightning protection system.	
7.1.6	The drawings shall be strictly followed except where interference occurs. In such cases, the routing shall be changed as directed by the Site Engineer without any price implication to Mahagenco.	

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7.2 CABLE TRAYS

- 7.2.1 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces will be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.
- 7.2.2 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.
- 7.2.3 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.
- 7.2.4 The cable trays shall be supported in general at a span of not exceeding 1.5 meters horizontally and 1.0 meter vertically.
- 7.2.5 Sufficient spacing not less than 300 mm shall be provided between trays and maintained to permit adequate access, for installing and maintaining the cables. In areas like Boiler, CHP etc. where excessive dust coal ingress is expected Vertical tray Arrangement shall be provided. In areas, where acid/alkali ingress is likely to occur, Fire Retardant, Corrosion resistance trays of glass reinforced plastic shall be used.
- 7.2.6 Complete cable tray support structure after installation shall be inspected/tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.
- 7.2.7 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship etc.
- 7.2.8 The Contractor shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.

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7.2.9	Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.	
7.2.10	Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.	
7.2.11	Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way. Space for free movement of O & M personal shall be provided in cable vaults/ cable spreader rooms.	
7.2.12	Cable tray/conduit system will be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.	
7.2.13	Cable tray/conduit system shall be electrically continuous and grounded, at an interval of 10 meters.	
7.2.14	Different voltage grade cables will be laid in separate trays when trays are run in tier formation. Power cables will normally be on top trays and control/instrumentation cable on bottom trays.	
7.2.15	Ladder type cable trays shall be used for laying HT & LT power cables only and perforated cable trays shall be used for all Instrumentation cables and Control cables.	
7.3	<u>CABLE AND CONDUITS</u>	
7.3.1	The Contractor shall install, terminate and connect up all cable and conduits as per approved drawings and cable schedules.	
7.3.2	Approximate lengths of cable and conduit runs will be shown by the contractor in the cable schedule for guidance only. Before commencement of work the Contractor shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.	

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7.3.3	The Contractor shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.	
7.3.4	Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.	
7.3.5	Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the owner's Engineer.	
7.3.6	At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.	
7.4	<u>CONDUIT AND ACCESSORIES</u>	
7.4.1	Conduit/pipes shall be used only in short lengths in certain areas upto 3m where required and/or as directed by the Engineer.	
7.4.2	The Contractor shall furnish all conduits complete with accessories as required.	
7.4.3	Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Contractor.	
7.4.4	Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.	
7.4.5	The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.	
7.4.6	Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.	
7.4.7	Pull boxes will be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.	

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7.4.8	Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting etc. Conduits shall be supported at least every 1000 mm.	
7.5	<u>CABLES : STORAGE AND HANDLING</u>	
7.5.1	Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.	
7.5.2	Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.	
7.5.3	In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.	
7.5.4	For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending.	
7.5.5	The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.	
7.5.6	While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums	
7.5.7	Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.	
7.6	<u>CABLE LAYING</u>	
7.6.1	Cable shall generally be installed in ladder and perforated type prefabricated trays uniformly loaded proportionate to the size of the	

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tray except for some short run in rigid/flexible conduit for protection or crossings. Trays shall be away from steam, oil, coal pipelines and hot ducting. Cable Trays should not be immediately below or above any steam line.		
7.6.2	Cables laid on trays and risers shall be neatly dressed and clamped as stated subsequent clauses at an interval of 750 mm. for horizontal and 500mm for vertical runs, in case of both power, control and instrumentation cables.	
7.6.3	All single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon trefoils clamps at an interval of 750 mm for horizontal run or 500mm for vertical run.	
7.6.4	All H.T. multicore power cables and L.T. multicore power cables with cross-sectional area including & above 95 sq.mm shall be clamped individually by glass reinforced nylon claw type clamps.	
7.6.5	L.T. power cables of cross sectional area less than 95 sq.mm. and all control and Instrumentation cables shall be clamped in bunches with 25x3 mm Aluminium strip. The number of cable in one bunch shall not exceed eight (8).	
7.6.6	Prior to laying of cables inside the indoor and outdoor trenches, the contractor shall properly clean the trenches.	
7.6.7	When cables crosses road/railway track, adequate protection shall be provided in the form of hume/galvanised iron pipes laid at a minimum depth of 1 meter below ground.	
7.6.8	After completion of installation and prior to connection, all power cables shall be subjected to a high potential test. Machine ferruling shall be adopted.	
7.7	<u>CABLE TAGS & MARKERS</u>	
7.7.1	Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 8 to 10M and exit from any equipment, junction box	

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7.7.2	When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.	
7.7.3	The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.	
7.7.4	The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.	
7.7.5	The Contractor shall furnish and install all tags and markers stated above.	
7.7.6	For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.	
7.8	<u>CABLE TERMINATION AND CONNECTION</u>	
7.8.1	The termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.	
7.8.2	The work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement.	
7.8.3	Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.	
7.8.4	Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.	
7.8.5	The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.	

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7.8.6	The Contractor shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.	
7.8.7	If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.	
7.8.8	Control/instrumentation cable cores entering control panel/switchgear/MCC etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block	
7.8.9	The Contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.	
7.8.10	Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number. Machine ferruling shall be adopted.	
7.8.11	Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.	
7.8.12	All cable entry Points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.	
7.9	<u>TERMI-POINT CONNECTION</u>	
7.9.1	The conductor (solid or stranded) is forced against the contact area of the 2.4 x 0.8 mm or 1.6 x 0.8 mm connection pin by means of a tin-coated bronze clip, which maintains a constant pressure. In the Maxitermi-point method, 2.4 x 0.8 mm pins is used without exception.	
7.9.2	The conductor is "shot" onto the pin together with the clip. The resulting friction causes both the wire and the contact area of the pin to be cleaned and any oxide layers to be penetrated.	

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7.9.3	Apart from this the wire and the clip are deformed in such a way that a gas-tight connection with very good electrical and mechanical properties is established.	
7.9.4	A special manually or pneumatically driven gun is required. Up to 3 adjacent connections can be "shot" onto one pin. In most cases only one clip at the base of the pin is attached. The sections above usually remain vacant. Any part of a connection pin may be reused several times after removal of the existing clip connection. Contact areas below existing connections that have become vacant can be reused by pushing the connections above the vacant space downwards, so that the new connection can be "shot" on above the top connection. The single jumper wires need not be specially prepared as the end insulation is stripped within the tool.	
7.9.5	This connection method requires special insulation of the wires. The diameter of solid conductors is 0.8 mm the cross-section of stranded conductors 0.5 Sq.mm.	
7.9.6	The conductor is deformed greatly when attached and is to be shortened by 3 mm when disconnected and reused.	
7.9.7	Strips and special tools for termi-point connection shall be supplied by the Contractor.	
7.10	<u>CABLE JOINTS</u>	
7.10.1	Cable shall be installed without joints as far as practicable.	
7.10.2	If however jointing becomes necessary, it shall be made only by qualified cable jointer and strictly in accordance with manufacturer's recommendation.	
7.11	<u>GROUNDING</u>	
7.11.1	The Contractor shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian	

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	standards and enclosed grounding and lightning protection notes and details. 7.11.2 The grounding shall be done by conductors of sizes as laid down in grounding drawings and the same shall be connected to the risers of main ground mat. 7.11.3 For fabricated cable trays, a separate ground conductor (75x10 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 75x10 mm G.S. flat to maintain continuity of ground path. 7.11.4 All ground conductor connections shall be made by electric arc welding/brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. 7.11.5 All ground conductors shall be painted black for easy identification. 7.11.6 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint. 7.11.7 Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded. 7.11.8 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points. 7.11.9 The underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth shown in drawing but not less than 1 metre below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes as shown in the relevant drawing.	

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The Contractor will plan and organise works to lay the grounding mat in the same sequence in which the building and equipment foundation is being done. 7.11.10 Ground Electrode Ground electrodes will be 40 mm (min) dia and 3 metre long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by arc welding process. 7.11.11 Risers Risers are required for connecting the equipment and structures with the ground mat. These will be 1 No. 40 mm (min) dia M.S. rod. laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown. For every upper/lower floor the distance between two adjacent risers from the below the grounding grid shall not greater than 10meters. 7.11.12 Column Grounding All columns are required to be grounded by 1 no. 40 mm(min) dia M.S. rod from ground mat. Laying, supporting along with foundation, connecting at ground mat are within the scope of this specification. At least 300 mm length of the above rods shall be left free above the grade level/concrete floor level for connection with columns 7.12 <u>PAINING</u> 7.12.1 The Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of battleship grey (shade no. 632 of IS:5) synthetic enamel paint.		

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7.13 <u>GALVANISING</u> 7.13.1 The galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel has to be regalanised, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square meter of surface area and in addition, the thickness of the zinc deposit at any spot whatsoever shall not be less than 86 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument and reject any component which shows thickness of zinc at any location less than 86 microns. 7.14 <u>EXCAVATION AND BACK FILLING</u> 7.14.1 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections. 7.14.2 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work. 7.14.3 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation. 7.14.4 All excavation shall be backfilled to the original level with good consolidation. 7.15 <u>STEEL FABRICATION</u> 7.15.1 All racks, trays, supports, hangers & brackets wherever necessary shall be fabricated by the Contractor. 7.15.2 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge and burns so as not to cause any damage to personnel or cables.		

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7.16 <u>CLEANING UP OF WORK SITE</u> 7.16.1 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways. 7.16.2 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use. 8.0 <u>TESTS</u> 8.1 <u>SHOP TESTS</u> 8.1.1 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works. 8.1.2 Tests on panels/junction boxes shall include: (a) Wiring continuity tests. (b) High voltage and insulation tests. (c) Operational tests. 8.2 <u>SITE TESTS</u> 8.2.1 Contractor shall thoroughly test and Meggar all cables, wires and equipment to prove the same are free from ground and short circuit. 8.2.2 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced. 8.2.3 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.		

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Cable cores shall be tested for: (a) Physical damage (b) Continuity (c) Correctness of connections as per relevant wiring diagram (d) Insulation resistance to earth (e) Insulation resistance between conductors (f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc. 8.2.4 All equipment shall be demonstrated to operate in accordance with the requirements of this specification. 8.3 <u>TEST CERTIFICATES</u> 8.3.1 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.		

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<u>FIRE STOP MORTAR SEAL</u> <u>DATA SHEET-A</u>			
1.0	Fire Seal shall be dry cement with other chemical ingredients capable of controlled swelling, non-shrinking, homogeneous and smoke/gas-tight fire seal for cable and pipe penetration.		
1.1	Composition	:	It shall consist of inorganic binders, filters and light- weight aggregates with special additives and agents.
1.2	Colour	:	Preferably – Grey colour
1.3	Bulk Density	:	Approx. 550 gm./litre (Minimum)
1.4	Toxicity	:	It shall be Non-toxic
1.5	Combustibility	:	It shall be Non-combustible
1.6	P(H) value	:	7-11 (at working consistency)
1.7	Storage temperature	:	+ 5 deg.C to 50 deg.C in dry conditions.
1.8	Shelf life	:	Minimum Two years, in original unopened packing stored in a dry place
1.9	Packaging	:	Shall be packed in Moisture/ air tight container containing not more than 50 Kg.Fire Seal Compound.
1.10	Compressive Strength	:	0.6 N/mm ² (min)
1.11	Yield		1kg. Dry Mortar yields approx. 1.5- liter mixture of wet mortar
1.12	Fire Resistance	:	Fire Seal shall provide 3 Hrs. Fire Resistance.
1.13	Expansion	:	Approx. 3% by volume at 20 Deg.C
1.14	Recommended Uses	:	Recommended for wall openings, floor cut-outs and Fire Barrier in cable trenches.

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1.15	Approval	:	The FIRE SEAL should have approval of the Institution like CBRI, CPRI and vendor shall submit test reports for tests conducted within last 5 years from the date of bid submission at CBRI as per standards for organisations like NPCIL, Mahagenco, Mahatransco, BHEL, BARC for its fire retardant properties.
1.16	Ref Standard	:	UL-1479, ASTM E-814, BS 476, IS 12458
1.17	Experience	:	The application should have been done successfully preferably in Power Stations

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<u>FIRE RETARDANT COATING COMPOUND</u>			
<u>DATA SHEET – A</u>			
1.0 <u>FIRE RETARDANT COATING COMPOUND SHALL BE A READY TO MIX AND EASILY BRUSHABLE ONE</u>			
1.1	Composition	:	Fire Retardant coating compound shall be water based, solvent free (no thinning) coating comprising of thermoplastic resins, certain flame retardant chemicals and other inorganic incombustible fibers, filters and pigments. Fire Retardant should not contain asbestos fibers.
1.2	Colour	:	Preferably – Off White colour
1.3	Density	:	1.25 to 1.35 gm per cc.
1.4	Solid contents	:	70 to 75% by weight
1.5	PH value	:	7-11
1.6	Odour	:	It shall be odourless
1.7	Toxicity	:	It shall be Non-combustible & Non- toxic.
1.8	Storage temp	:	Max 50 Deg.C, must be protected from freezing
1.9	Shelf Life	:	Shall be min. 2 years, in original unopened packing & stored in dry place
1.10	Coating Thickness	:	Recommended Coating Thickness, min 2.0 mm

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1.11	Packing	:	Shall be packed in Sealed- moisture / air tight container containing not more than 50 Kg. Fire Retardant Compound	
1.12	Thinning	:	Shall be only by water	
1.13	Drying Time	:	8 hrs. touch dry	
1.14	Surface Finish	:	Rough	
1.15	Ref Standard	:	IEEE-383, IEC-331,332, Modified Swedish Chimney test.	
1.16	Fire Resistance	:	Fire Retardant Coating shall provide minimum 30 minutes fire resistance	
1.17	Limited oxygen Index (LOI)	:	Greater than 60	
1.18	Approval	:	The FIRE RETARDANT COATING COMPOUND should have approval of the Institution like CBRI, CPRI and vendor shall submit test reports for tests conducted at CBRI within last 5 years from the date of bid submission as per standards for organization like NPCIL, Mahagenco, Mahatransco, BHEL, BARC for its fire retardant properties	
1.19	Experience	:	The application should have been done successfully preferably in Power Stations	
2.0 FIRE RETARDANT COATING COMPOUND – SPECIAL FEATURES				
2.1	Alkali Resistance	:	A Fire Retardant coated cable shall not show any effect on application of 10% soap solution for half an hour and 2% solution of Sodium Bicarbonate for an additional half an hour.	
2.2	Current Carrying	:	On application of Fire Retardant coating, there	

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	capacity of cables		shall be no effect on the current carrying capacity of cable.
2.3	Flexibility	:	Fire Retardant Coated Cable may be bent 20 Times radius without cracking or peeling off.
2.4	Hydrocarbon Solubility	:	Shall have no effect
2.5	Mineral Oil Resistance	:	Shall be highly Resistance to immersion in mineral oil For 48 hours at room temp. There shall be no physical and chemical changes observed
2.6	Antirodent	:	Dry film of Fire Retardant shall be antirodent
2.7	Effect of Atmospheric Conditions	:	Shall be Highly Resistant to moisture and humidity.
2.8	Acid Resistance	:	No effect on application of 2% Conc. Sulphuric Acid on Fire Retardant coated cable.
2.9	Salt Water Resistance	:	A Fire Retardant coated cable will not show any effect when dipped in salt water for 16 days.
2.10	Water Resistance	:	A fire Retardant coated cable will not show any effect when dipped in water at 40° C for 10 days.

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ERECTION, CABLING, GROUNDING & LIGHTING PROTECTION SYSTEM

ANNEXURE – A

NOTES AND DETAILS FOR CABLING SYSTEM

1.0 GENERAL

- 1.1 These notes and details shall be read and construed in conjunction with Specification and the drawings meant for cable tray details and supporting arrangements in buildings, Trenches, Racks etc., enclosed elsewhere (Volume VII-B). In case of conflict between these notes and drawings, the latter shall prevail.
- 1.2 The Cabling System installation work shall conform to the requirements of the latest revisions of the following standards/codes
- (a) Indian Electricity Rules, 1956, with up to date amendment.
 - (b) I.S. Code of Practice.
 - (c) Installation drawings (Vol- VII-B cabling notes & details)

2.0 CABLE ROUTING/LAYING

- 2.1.1 Cables shall generally be laid on ladder and perforated type cable trays as applicable either in trenches or overhead supported from building steel/structures except in some cases cables may have to be laid underground and for short runs in conduits for protection or crossing.
- 2.1.2 For underground crossing of railways, roads etc. hume pipes shall be used and shall be laid at a depth of minimum 1000 mm such that cables shall not be damaged.
- 2.1.3 Only trenches shall be acceptable for cable laying in transformer yard area. No trench is acceptable in other areas of plant. The cable racks shall be supported from Boiler structure in vertical configuration with suitable cover to avoid deposition of coal dust as far as practicable.

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2.1.4 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. Power cables shall be on top trays and Control/Instrumentation cables on bottom trays, and it is recommended that trays for cables of different voltage levels be stacked in descending order with higher voltage level above. 2.1.5 Cables for redundant equipment/system shall be run in separate trays in separate route. 2.1.6 Cables from two different services viz. supply from station board and supply from unit board shall be fully segregated to prevent simultaneous damage due to fire in one of the services. 2.1.7 Low level signal cables and other special Instrumentation and Control cables shall run in separate trays. In general, a minimum of 1500 mm clearance shall be maintained between these cables and noise generating equipment (large motors, generators, transformers etc.). 2.1.8 The cable spreaders shall have the provision of fire proof partition wall. 2.1.9 The floor of the cable spreader rooms will have to be made water proof so that water does not percolate to lower levels in the event of fire fighting operations. Adequate arrangement for efficient drainage of water shall be provided. The cable raceways should also be suitably curved to avoid water entry through this place. 2.2 <u>CABLE TRAYS/SUPPORTS</u> 2.2.1 Cable trays and covers shall be pre-fabricated type, constructed from minimum 14 SWG sheet steel for trays and 16 SWG for covers and hot-dip galvanized after fabrication. 2.2.2 Cable tray supports shall be cantilever type for each installation. All supports and hardware shall be hot-dip galvanized. 2.2.3 Standard cable tray width shall be 600 mm. However, trays with 450, and 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose only,		

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perforated type cable trays of width 150,100 mm and 600, 450, 300 mm shall be used depending on site requirement, the minimum depth of cable tray shall be 100mm for the cable tray size of 300mm and above 2.2.4 Cable trays shall be ladder type with 250 mm rung spacing, 100 mm depth and rung width not less than 50 mm. 2.2.5 All weld for cable tray supports shall have a minimum throat thickness of 6 mm. 2.2.6 Cable trays in areas subjected to excessive coal dust, or mechanical damage will have hot-dip galvanized sheet metal tray cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run. Where covers are used on trays containing power cables, consideration should be given to ventilation requirements. In area where acid/alkali ingress is like to occur, cable trays of glass fibre reinforced plastic with fire retardant & corrosive resistance properties shall be used. 2.3 <u>CONDUITS</u> 2.3.1 Conduits shall be rigid steel coated type; minimum size of conduit shall be limited to 19 mm. 2.3.2 Steel conduits shall be seamed by welding and flo-coat metal conduit/hot-dip galvanised. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS: 9537 Part-II. In Chemical Handling Area, Battery Room, WTP, etc. HDPE conduits shall be used for better resistance to corrosion 2.3.3 Conduit runs shall be supported at an interval of 750 mm for vertical run and 1000 mm for horizontal run. 2.3.4 Conduits shall be sized so that conduit fill (ratio of total cable area to conduit area) shall not exceed the following: <table border="0"> <tr> <td>One Cable</td><td>:</td><td>53%</td></tr> <tr> <td>Two Cable</td><td>:</td><td>31 %</td></tr> </table>			One Cable	:	53%	Two Cable	:	31 %
One Cable	:	53%						
Two Cable	:	31 %						

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Three Cable & Up : 40 % 2.3.5 Conduit runs shall be provided with necessary bends as required. 2.4 <u>INSTALLATION</u> 2.4.1 The Contractor shall install, terminate and connect up all cables and conduits with supporting arrangements as per drawings, cable schedules and interconnection chart/drawings. 2.4.2 The HV power cables of 11 kV/3.3 kV shall be laid in trays or racks as follows: (a) In single layer only (b) 3 core cables to be laid giving one diameter gap of the largest diameter adjacent cable. (c) Single core cables to be laid in trefoil formation with spacing between trefoils equal to diameter of the trefoils. 2.4.3 1100V grade Multicore power cables with dia more than 95 sq. mm shall be laid in single layer touching. 2.4.4 1100V grade multicore power cables with diameter upto and including 95 sq. mm shall be laid in two layer & single core cables shall be laid in trefoil formation with gap of 2D between trefoils in single layer only. 2.4.5 Control and Instrumentation cables can be laid up to a maximum of three layers in each tray. 2.4.6 The trays shall be run with a vertical spacing of 300 mm for overhead cable trays as well as inside cable trenches. A minimum of 225 mm clearance shall be provided between the top of tray and beams, cold piping, 500 mm clearance for hot piping/object to facilitate installation of cables in tray.		

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2.4.7	Adequate pull boxes shall be provided in conduit run to facilitate cable pulling in long runs and also to ensure that there will be no more than 270 Deg. bends between pull points.	
2.4.8	Cable tray/conduit system shall be installed to accommodate cable manufacturer's recommended maximum pulling tension and minimum bending radius.	
2.4.9	All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows : (a) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways. (b) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire. (c) For all H.T., L.T., Relay and Control panels, Contro desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate	
2.4.10	All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.	
2.4.11	The portion of galvanised steel, which, if required, undergoes any welding at site shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.	
2.4.12	The cables shall be coated with fire protection coating as specified elsewhere.	
2.4.13	In addition to all the tests as per relevant standards like Fire rating test, hose stream test, accelerated aging test, fire rating test on mortar seal system built out of accelerated aged components followed by hose stream test, temp rise test for cable in fire stop, water absorption test followed by fire rating test,	

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flame resistant test for coating compound, anti rodent test as per relevant standards, modified Swedish Chimney test shall also be conducted in presence of owner. 2.5 <u>IDENTIFICATION</u> 2.5.1 The complete cabling system shall be properly identified. Methods for identification of cabling system shall be furnished to the successful tenderer and the Contractor shall strictly adhere to the said methods. 2.5.2 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule. 2.5.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate, projected above ground level. 2.5.4 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/ conduit entry, at each bend and at every 8 to 10 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, MCC, control & relay panels etc. wherever required for cable identification, such as where a number of cables enter together through a gland plate. 2.5.5 Separate coloured paint strips shall be applied for identification of different types of trays depending upon types of usage/applications/area as below: <table border="0"> <tr> <td>HV/MV cables</td><td>Red strips</td><td>2 inch width each, numbers equally spaced at 5 mtrs, interval</td></tr> <tr> <td>1.1kV power cables</td><td>Yellow strips</td><td>----do----</td></tr> <tr> <td>1.1kV control cables</td><td>Blue strips</td><td>----do----</td></tr> <tr> <td>Instrumentation cables</td><td>Green strips</td><td>----do----</td></tr> </table>			HV/MV cables	Red strips	2 inch width each, numbers equally spaced at 5 mtrs, interval	1.1kV power cables	Yellow strips	----do----	1.1kV control cables	Blue strips	----do----	Instrumentation cables	Green strips	----do----
HV/MV cables	Red strips	2 inch width each, numbers equally spaced at 5 mtrs, interval												
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ERECTION, CABLING, GROUNDING & LIGHTNING PROTECTION SYSTEM

ANNEXURE – B

NOTES AND DETAILS FOR GROUNDING & LIGHTNING PROTECTION

1.0 GENERAL

- 1.1 These notes and details shall be read and construed in conjunction with grounding and lightning protection drawings and specification. In case of conflict between these notes and drawings, the latter shall prevail.
- 1.2 The grounding and lightning protection system installation work shall conform to the requirements of the latest editions of the following standards/codes:
- (a) Indian Electricity Rules, 1956.
 - (b) National Electrical Code, 1985.
 - (c) Code of Practice for Earthing (IS: 3043)
 - (d) Protection of Buildings and Allied Structures Against Lightning (IS: 2309)
 - (e) IEEE 80 & IEEE 665

2.0 GROUNDING SYSTEM

2.1 MAIN GROUNDING MAT/GRID.

- 2.1.1 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise. The size of ground grid conductor shall be bare 40 mm (min) dia. mild steel rod.

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2.1.2	A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.	
2.1.3	In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.	
2.1.4	Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.	
2.1.5	Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.	
2.2	<u>GROUNDING ELECTRODES</u>	
2.2.1	The ground electrodes shall be Pipe Electrode, 100 NB, 3000 mm long heavy duty C.I. Pipe. These shall be fabricated and driven into the ground by the side of grounding mat conductors and connected to the ground mat conductors.	
2.3	<u>RISERS</u>	
2.3.1	All risers/pigtail from the ground grid shall be 40 mm (min) dia mild steel rod and shall be projected 300 mm above grade level/concrete floor level unless otherwise shown.	
2.4	<u>EARTHING CONDUCTOR</u>	
2.4.1	75x10 mm galvanised steel flats shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing.	

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2.4.2	These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground.	
2.4.3	Earthing conductors along their run on column, wall etc. will be supported by suitable welding/clamping at intervals set exceeding 750 mm	
2.4.4	Earthing conductors shall be embedded in concrete floor of the building without having direct contact with the reinforcement rods. Minimum concrete cover above earthing flat shall be 50 mm.	
2.4.5	At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.	
2.5	<u>GROUNDING OF EQUIPMENT AND STRUCTURES</u>	
2.5.1	All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.	
2.5.2	Two separate and distinct ground connections shall be provided for grounding electrical equipment frameworks in compliance with I.E. rules.	
2.5.3	All Electrical equipment will be furnished with two (2) separate ground pads with tapped holes, bolts and spring washers. The connection between these ground pads and the grounding grid shall be made by short and direct earthing conductors free from kinks and splices.	
2.5.4	Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.	
2.5.5	The generator neutrals, transformer neutrals, earthing terminals of lightning arrestors, coupling capacitor shall be directly connected to Pipe Earth	

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Electrode which in turn shall be connected to station grounding mat. Pipe Earth Electrode shall be 100 NB, 3000 mm long heavy duty C.I.Pipe. Treated Earth Pits shall be provided for Generator & transformer neutral earthing. 2.5.6 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors. 2.5.7 Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends. 2.5.8 (a) The cable trays inside the cable trenches shall be grounded thru' one (1) no. 40 mm (min) dia M.S. Rod at an interval of ten (10) metres. One end of this rod is connected with riser from grounding mat and the other end which is projected inside the cable trench shall be connected with one (1) 75x10 mm G.S. flat which runs horizontally along the cable trench. This earthing conductor shall be securely attached to each tray section of cable tray/trays forming a solidly grounded tray system through 75x10 mm G.S. flats. (b) A continuous 75x10 mm G.S. flat earthing conductor shall run along the supporting structure of overhead cable trays/cable shafts. This earthing conductor shall be attached to each section of cable tray/trays through 75x10 mm G.S. flats. 2.5.9 Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement. 2.5.10 The street lighting poles, junction boxes mounted on the poles etc. shall be connected to ground grid at minimum two points. 2.5.11 The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.		

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2.5.12	The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.	
2.5.13	The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.	
2.5.14	The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.	
2.6	<u>EARTHING OF CABLE</u>	
2.6.1	The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.	
2.7	<u>JOINTING AND CONNECTION</u>	
2.7.1	All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.	
2.7.2	The bending of the large diameter ground conductor where necessary shall be done by gas heating.	
2.7.3	The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.	
2.7.4	The connections between the riser/pigtail and earthing conductors (galvanised steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.	
2.7.5	The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.	

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2.7.6 The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GS bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

2.7.7 Equipment/structures ground connections after properly checked and tested shall be coated with weather resistant paints/cold galvanising paints.

2.8 THE SIZES AND MATERIALS OF GROUND CONDUCTORS USED IN GROUNDING SYSTEM ARE LISTED BELOW :

	DESCRIPTION	SIZE	MATERIAL
(a)	Main Grounding Grid conductor	40 mm dia. Rod (Min)	Mild Steel
(b)	Riser / Pigtail from Grounding Grid / Mat	40 mm dia. Rod	- Do -
(c)	Electrode for other than system neutral	40mm dia Rod(min)	Mild Steel
(d)	Electrode for system neutral	100NB CI pipe	CI
(e)	Conductor used for connection of various equipment/structures as listed below		
	(i) E.H.V. Substation Equipment	Flats 75x10 mm	Galvanized Steel
	(ii) 11 kV/3.3kV Equipment	75x10 mm Flat	- Do -
	(iii) Structures, Bus Duct Control Panels, Cable Trays etc.	75x10 mm Flat	- Do -

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	DESCRIPTION	SIZE	MATERIAL
	(iv) 415V Power Control Centres, Motor Control Centres, Distribution Boards etc.	75x10 mm Flat	- Do -
	(v) Local Panels, Lighting Panels	50 x 6 mm Flat	- Do -
	(vi) Motors		
	Above 90 kW	75x10 mm Flat	- Do -
	Above 30 kW upto 90 kW	50 x 6 mm Flat	- Do -
	Above 5 kW upto 30 kW	25 x 3 mm Flat	- Do -
	Upto 5 kW	8 SWG Wire	Galvanized Steel
	(vii) Miscellaneous Items, viz. Push Button Station Junction Boxes etc.	8 SWG Wire	Galvanized Steel

3.0 LIGHTNING PROTECTION SYSTEM

3.1 AIR TERMINATIONS

- 3.1.1 The vertical air terminal rods shall be installed at the roof of buildings (including power house building), to protect these objects from lightning strokes.
- 3.1.2 The vertical air terminal shall be made of 20 mm dia. Galvanised steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.
- 3.1.3 The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion

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	embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them. 3.1.4 All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75x10 mm galvanized steel flats. 3.1.5 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees. 3.2 <u>SHIELDING MASTS</u> 3.2.1 The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house main building. 3.2.2 The shielding mast shall be made of galvanized steel pipe and the height of the same shall be decided considering the zones to be protected. 3.2.3 Each shielding mast shall be connected to grounding grid by a down conductor 75x10 mm. Galvanized steel flat run along the building column. In addition all power house building columns joints shall be electrically bonded. 3.3 <u>DOWN CONDUCTORS</u> 3.3.1 The down conductors shall be 75x10 mm galvanised steel flats. The sizes of down conductors and horizontal conductor provided for lightning protection of conveyer gallery shall be 25 x 4 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/ structure and other end connected to the nearest 40 mm (min) dia. mild steel rod riser from ground electrode. 3.3.2 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level. 3.3.3 The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located at approximately 1500 mm above ground level.	

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3.3.4	The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall and column/ structure at about 750 mm intervals unless stated otherwise in the drawing.	
3.3.5	At all supports for down conductor along the column/wall of the buildings; chimney etc. the portion embedded inside the building concrete should not touch the reinforcement bars.	
3.3.6	All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.	
3.3.7	The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.	
3.4	<u>ELECTRODES (FOR LIGHTNING PROTECTION)</u>	
3.4.1	The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.	
3.4.2	All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which will be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.	
3.5	<u>RISER (FOR LIGHTNING PROTECTION)</u>	
3.5.1	All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.	
3.6	<u>JOINTING & CONNECTION</u>	
3.6.1	All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.	

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3.6.2	The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.	
3.6.3	The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.	
3.6.4	All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.	
3.6.5	The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.	
3.6.6	The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.	
3.6.7	The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).	
3.6.8	The steel to copper connection shall be brazed type.	
3.7	<u>LIGHTNING PROTECTION OF OTHER AREAS.</u>	
3.7.1	The lightning protection of other areas shall be done by lightning masts on the top of steel towers. In addition, shield wires shall be used where required. The shield wire shall be strung across the top of the steel tower and/or power house structure.	
3.7.2	The shield wire which shall be brought down up to bottom of steel tower shall be connected to the earthing conductor (75x10 mm galvanised steel flat) which in turn connected to the riser (from the main grounding mat/grid).	
3.7.3	The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of	

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poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

3.8 THE SIZES AND MATERIALS OF EARTHING CONDUCTORS TO BE USED IN LIGHTNING PROTECTION SYSTEM ARE LISTED BELOW:

	DESCRIPTION	SIZE	MATERIAL
(a)	Vertical Air Termination	20 mm dia Rod	Galvanised Mild steel
(b)	Horizontal Conductor	(i) 75x10 mm Flat	Galvanized steel
		(ii) 25 x 4 mm Flat	- Do -
(c)	Down Conductors	(i) 75x10 mm Flat	- Do -
		(ii) 25 x 4 mm Flat	- Do -
(d)	Riser From Electrode/ Grounding Mat	40 mm(Min) dia Rod	Mild Steel
(e)	Electrode for Lightning Protection	40 mm dia(Min) Rod 3000 mm long	- Do -
(f)	System Neutral	75x10mm	Flat galvanized Steel

NOTE:

- In addition to above, all materials as required such as G.I. pipes of appropriate length, diameter and thickness will be provided for lightning masts of Power House building and Switchyard.

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ERECTION, CABLING, GROUNDING & LIGHTING PROTECTION SYSTEM

ANNEXURE – C

GENERAL PRACTICE FOR APPLICATION / INSTALLATION SCHEME FOR FIRE STOP MORTAR SEAL & FIRE RETARDANT CABLE COATING COMPOUND

- 1.0** Fire Barriers using Fire Stop Mortar Seal shall be installed at following locations. The thickness of Fire Barrier shall be minimum 225mm.so as to achieve 3 hr fire rating.
- 1.1** **CONTROL ROOM / CABLE VAULTS AND IN PLANT AREA.**
- (a) Panel bases in control room shall be sealed (wherever any other type of fire sealing system is not already installed and wherever it is structurally and maintenance wise feasible to install.)
 - (b) All wall openings and floor openings in control room/cable vaults shall be sealed.
 - (c) All cable entry openings from trenches or overhead cable trays racks shall be sealed.
- 1.2** **TRENCHES/SWITCHYARD**
- (a) Barriers shall be installed inside the trenches at every intersection or Tee joints and bends at every 2 meters from centre line of cable rack inside the trench.
 - (b) Barriers shall be installed at every 15 meters in straight runs of trenches.
 - (c) Barriers shall be installed inside the trenches at the centre of R,Y & B downcomers into the trenches from C.T units.
 - (d) Barriers shall be installed on left side of R and right side of B inside the trench at approximate 3m distance.

CONSULTANT : PROCON ENGINEERS

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2.0	Fire Protective Coating shall be applied at following locations. The average thickness of the coating shall be 2 mm.	
2.1	<u>CONTROL ROOM / CABLE VAULTS AND IN PLANT AREA.</u>	
	(a) All vertical cables coming out below the panels shall be coated to a full length of vertical drop from bottom of panel plus 1.5 to 2.5 mtrs. Horizontal run after the bend. (b) All vertical cable runs anywhere in the area are to be coated full. (c) All horizontal cable runs to be coated for a length of 1.5 mtrs at an interval of every 2 to 3 mtrs. At bends / intersections and Tee joints, coating should be done 2 mtrs from centre line of cable tray on each side.	
2.2	<u>TRENCHES/SWITCHYARD</u>	
	(a) All vertical cables coming down into the trenches switchyard from the equipment are to be coated full. (b) At the intersection / joints / bends in the trenches all cables to be coated 2 mtrs from centre line of the cable tray rack. (c) All horizontal cable runs to be coated for a length of 3 mtrs in the centre of every 15 mtrs i. e. at the centre of two fire stop mortar seal barriers and in the same proportion if the distance is less than 15 mtrs and more than 6 mtrs. <u>NOTE:</u> The above instructions are general and the application shall be carried out as per suitability to individual site condition to achieve maximum fire protection.	
2.3	<u>TYPE TEST ON FIRE STOP MORTARSEAL/FIRE RETARDANT CABLE COATING COMPOUND</u>	
	The type tests to be carried out in presence of Owners representative, as per latest applicable standards for FIRE STOP MORTAR SEAL& FIRE	

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RETARDANT COATING for floor and wall opening/fire stop system for bottom of electrical switchgear/MCC/panel base are as under (a) Fire rating test (b) Hose stream test (c) Accelerated aging test (d) Fire rating test on the MORTAR seal system built out of accelerated aged components followed by hose stream test (e) Temp rise test for cables in the fire stop (f) Water absorption test followed by fire rating test. (g) Flame resistant test for fire retardant coating material/modified Swedish chimney test (h) Anti-rodent test.		

CONSULTANT : PROCON ENGINEERS

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPP	SPEC. NO.: PE-TS-415-165-N002		
		SECTION: I		
		SUB-SECTION: IC		
		REV. NO. 0	DATE	02.11.18
		SHEET 1	OF 1	
	SPECIFIC TECHNICAL REQUIREMENTS			

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C &I)

	1X660 MW BHUSAVAL TPP CONTROL & INSTRUMENTATION Technical specification for NATURAL DRAFT COOLING TOWER	SPEC NO.: PE-TS-415-145-IXXX	
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7. QAP FOR LOCAL CONTROL PANEL
8. MANDATORY SPARES
9. KKS PHILOSOPHY

	1X660 MW BHUSAWAL TPP Technical specification for NATURAL DRAFT COOLING TOWER	SECTION: C
	SPECIFIC TECHNICAL REQUIREMENTS (C&I)	
SPECIFIC TECHNICAL REQUIREMENTS (C&I):		
1.0	Operation & Control of NATURAL DRAFT COOLING TOWER system shall be from plant DCS (BHEL Scope).	
2.0	Bidder to include all the instruments (for the measurement of pressure, temperature, level, flow vibration etc.) required for the package along with necessary fittings, accessories and valve manifold etc. All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. Anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.	
3.0	All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow, vibration etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all other accessories required for mounting / erection of these local instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm ² .	
4.0	The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.	
5.0	The junction boxes/LIEs for termination of instruments /solenoid valve limit switches etc are in bidder's scope.	
6.0	Removable type Pitot Tube at each hot water inlet pipe header to measure the flow (during Performance Guarantee Test only). The Pitot tube shall be left with customer after the completion of the test.	
7.0	Pressure and Temperature measuring Instruments at hot & cold water duct/piping at terminal points shall be provided. Further, instrument tapings	

	1X660 MW BHUSAWAL TPP Technical specification for NATURAL DRAFT COOLING TOWER	SECTION: C
	SPECIFIC TECHNICAL REQUIREMENTS (C&I)	
	provision on hot duct/piping and cold water duct/piping for carrying out flow and temperature measurement during Performance Guarantee test.	
8.0	Anemometer (for measuring of wind velocity) and Psychrometer shall be supplied.	
9.0	All testing and calibrating instruments required for site performance tests shall be arranged by the supplier without any extra cost and time implication.	
10.0	The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.	
11.0	Vendor representative shall be available for 3-4 days at BHEL Electronic Division (EDN) Bangalore during testing of DCS.	
12.0	Vendor representative shall be available for 6-7 days during commissioning time at site.	
13.0	The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.	
14.0	For instrument & control cable scope of supply refer 'Electrical scope sheet between BHEL & vendor'.	
15.0	Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware as per instrument installation diagram shall be in bidder's scope.	
16.0	The make of all the items shall be from approved sub-vendor list.	
17.0	Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, cable interconnections details for complete system shall be in Bidders' scope.	
18.0	Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract: • Control & operational write-up for the system • Recommended control scheme/ logic diagram • Process manuscript for implementation in DCS • List of Drives (Solenoid valves etc)	

	1X660 MW BHUSAWAL TPP Technical specification for NATURAL DRAFT COOLING TOWER	SECTION: C
	SPECIFIC TECHNICAL REQUIREMENTS (C&I)	
• I/O list (DCS) • GA & wiring diagram of local panel. • Power requirement. • Field instruments quality plan. • Instruments data sheet. • JB grouping document. • Cable schedule and cable interconnection drawing. • Instrument schedule • Alarm Schedule • SOE schedule • Instrument hook-up diagram. • Any other document decided during detailed engineering. NOTES: 1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage. 2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL. 3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication. 4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.		

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FIELD SENSOR & INSTRUMENTS SPECIFICATIONS

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1. Float material : SS-316
 2. Wetted parts : SS-316
 3. Float chamber : Stainless steel/Carbon steel,
construction welded
 4. Float chamber : Side mounted
mounting
 5. Fluid connection : Side – Side
 6. Fluid connection size : 1" ANSI RF Flange (rubber line, if
required)
 7. Drain : ½ inch NPT with Plug
 8. Pressure rating of
chamber : Minimum 1.5 times of design pressure
 9. Repeatability : +/- 1.5 mm or better
 10. Switch housing : Stainless Steel
 11. Switch housing type : IP- 65
 12. Type of switch : Snap acting magnetically operated
hermetically sealed
 13. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
 14. Accessories :
 - a) Counter flange, nuts
& bolts, suitable
gasket etc.
 - b) Steel globe type
drain valve
 - c) ½"NPT cable gland
-

d) Stainless steel nameplate with alpha-numeric engraved for service and tag

15. Application : During Detail Engineering on Owner's approval

3.04.00 FLOW SWITCH

1. Type : Paddle /Piston/Disk
2. Wetted part material : Stainless steel or Hastelloy for acidic application
3. End connection :
 - a) Threaded upto 1" line size with integral Tee
 - b) Flanged for line size > 1 ½"
4. Enclosure material : Stainless Steel
5. Enclosure class : IP 65
6. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
7. Repeatability : 2%
8. Cable connection : ½"NPTF
9. Accessories :
 - a) Tee, Counter flange, nuts & bolts, suitable gasket etc
 - b) ½"NPT cable gland
 - c) Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

-
1. Type	:	RADIO FREQUENCY
Sensing probe		
2. Material	:	SS-316
3. Mounting	:	Threaded
Application		
4. Temperature	:	250°C (Max.)
Electronic Controller		
5. Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6. Relay Output	:	2 SPDT (240V AC, 5A)
7. Ambient Temperature	:	50 °C
8. Enclosure Protection	:	IP-66
9. Enclosure Housing	:	SS
		Normal Level
		Power On
10. Local LED Indication	:	Alarm Level
		Probe Healthy
11. Switching Repeatability	:	±0.5%
		Co-axial cable for probe connection to
		controller
12. Accessories	:	SS Tag plate
		½" NPT Cable Glands
13. Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1. Type	:	Conductivity discrimination
2. Probe MOC	:	SS-316
3. Mounting	:	Flanged on external cage
Application		
4. Temperature	:	250°C (Max.)
5. Test Pressure	:	Two times rated pressure
-

-
6. Input Supply Voltage	:	240V AC $\pm$ 10%, 50 Hz.
7. Input	:	Four independent channel with selectable switching threshold for water conductivity
8. Relay Output	:	2 SPDT (240V AC, 5A)
9. Ambient Temperature	:	50 °C
10. Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
11. Enclosure Housing	:	SS HI,LO, HIGH-HIGH, LOW-LOW
12. Local LED Indication	:	Power Fault
13. Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
14. Application	:	During Detail Engineering on Owner's approval

3.07.00 TEMPERATURE SWITCH

1. Type	:	Bimetallic or gas filled
2. Sensing Element	:	SS-316
Material		
3. Bulb Material	:	SS-316
4. Capillary	:	Stainless Steel armored
-

 approval

 4.00.00 **LOCAL INSTRUMENTS**

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1. Type	:	Bourdon/Bellows/Diaphragm
2. Sensing & Socket	:	SS-316
3. Movement Material	:	SS-316
4. Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5. Dial Size	:	Generally 150 mm
6. Scale	:	Black lettering on white in 270 O arc.
7. Window	:	Shatterproof glass
8. Range Selection	:	Normal process pressure: 50~70 % of range
9. Over-range Protection	:	125% of maximum range by internal stop. External stop at zero For Zero adjustment (Micrometer screw external)
10. Adjustment	:	For Range adjustment (Micrometer screw internal).
11. Element Connection	:	Argon welding
12. Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13. Performance	:	Accuracy of ± 1.0 % of span or better
14. Operating ambient	:	0 - 50 °C
15. Safety Feature	:	Blow out disc /diaphragm at the back
16. Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals
-

for corrosive/ viscous/ solid bearing or slurry type fluid applications

c) 3-Way SS316 Gauge cock for pressure gauges

5-valve SS316 manifold from

d) barstock for differential pressure gauge

e) Siphons for steam and hot water services

17. Nameplate : Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1. Type : Float and Board

2. Float Material : SS-316

3. Float Cable : SS-316

4. Indicator Assembly : Epoxy painted Aluminium

5. Guide wire spring assembly : SS-316 (2 Nos.)

6. Guide Wire Anchor : SS-316

Anodized Aluminium with engraved marking (Minimum graduation 10mm),

7. Scale Board :

mounting brackets and suitable hardware required as per tank height

8. Elbow Assembly : Anodized Aluminium

9. Flanges : RF , ANSI 150 , SS (3 Nos.)

10. Accuracy : ± 10 mm or better

11. Accessories : All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material	:	
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
			Rubber lined corrosion resistant
4.		:	ii. stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks
			ii. Drain Valves
			iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate
			iv. Illuminating lamps, Mica shield as required
			v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ° C
			For larger lengths (greater than 1200mm), additional gauge glasses
9.	Other details	:	shall be provided with minimum of 50 mm overlap.
-

Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).

7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X 1/2" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	1/2" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass
-

		cover conforming to IP 65.
7.	Dial size	: 150 mm
8.	Scale	: Black lettering on white background in 270 Deg.C arc
9.	Over range protection	: 125 percent of FSD
10.	Capillary Glanding	: 1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	: Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	: ½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	: 50 mm
14.	Compensation	: a) Capillary compensation
15.		: b) Case compensation
16.	Performance	: a) Accuracy : + /- 1.0 percent of full scale Deflection
		: b) Repeatability : Less than 0.5 percent of full range
		: c) Response time: 15 seconds (max.).
17.	Capillary length	: 3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	: Shatter proof glass
19.	Nameplate	: Tag number, service engraved in stainless steel tag plate
20.	Accessories	: SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	: SS-316
2.	Manufacture	: Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

-
3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel
-

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	CONTROL & INSTRUMENTATION	VOLUME	
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QAP FOR INSTRUMENTS



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT		P	W	V	
6	ACCESSORIES AS APPLICABLE	100%		P	W	V	
7	DEGREE OF PROTECTION	ONE / LOT		P	W	V	
8	OVER PRESSURE TEST	100%		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out routine test for 100%
4. Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL/TAG NO.						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS CHECK	100%		P	W	V	
3	ACCURACY	100%		P	W	V	
4	SWITCHING DIFFERENTIAL	100%		P	W	V	
5	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT		P	V	V	
7	HV / IR	RANDOM		P	W	V	
8	DEGREE OF PROTECTION	TYPE TEST		P	V	V	
9	THERMOWELLS						
	DIMENSIONS, PROCESS CONN	100%		P	W	V	
	MATERIAL TC	ONE / LOT		P	V	V	
	HYD TEST	100%		P	W	V	
	IBR CERTIFICATE, IF APPLICABLE			P	V	V	
10	REPEATABILITY	100%		P	V	V	
11	HYSTERESIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. Manufacturer to carry out routine test for 100%



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST				P	V	V
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE, WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material corelation is not available, MFR's compliance to be provided
- IBR certificates shall be provided wherever required.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

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Note :

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material correlation are not available manufacturer's compliance to be provided.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE ELEMENT

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL No./TAG No.						
	PROCESS CONNECTION						
2	STABILITY			P	W	V	
3	INSULATION RESISTANCE			P	W	V	
4	ENCLOSURE CLASS			P	W	V	
5	RESPONSE TIME			P	W	V	
7	ACCURACY			P	W	V	
8	HYDROSTATIC TEST			P	W	V	
9	ELECTRICAL CHARACTERISTIC OF SENSOR (CONTINUITY OF T/C WIRES & INSULATION RESISTANCE OF RTD LEADS w.r.t. BODY			P	W	V	
10	TEMP CURVES / CHARTS			P	V	V	
11	AMBIENT TEMP. EFFECT CHECK			P	W	V	
12	HV TEST			P	W	V	

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
- IBR certificate to be provided, if applicable

CHECK LIST FOR MAGNETIC TYPE FLOW METER

[illegible]

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1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUNCTIONAL TEST			P	W	V	

Legend :

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Note :

1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION	1 OF TYPE	APPROVED SPEC./ DATA SHEETS	P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST	FOR LOT	APPROVED SPEC./ DATA SHEETS	P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK			P	V	V	
5	REVIEW OF TC FOR MATERIALS OF			V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
6	HOUSING	TYPE TEST	AS PER APPD DWG	V	V	V	
	REVIEW OF TC FOR DEGREE OF PROTECTION						
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- IBR certificate to be provided if called for in specn.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST	P	W	V			
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE	P	W	V		
5	REVIEW OF TC FOR	FOR LOT	V	V	V		
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V		
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V		

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material corelation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION	ONE / LOT		P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR			P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE		P	W	V		

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.

CHECK LIST FOR SIGHT FLOW INDICATOR

[illegible]

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1. Quantum of check shall be as below :
100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL

	1X660 MW BHUSAWAL TPP	SPEC NO.: PE-TS-415-145-IXXX	
	CONTROL & INSTRUMENTATION	VOLUME	
	Technical specification for	SECTION	
	NATURAL DRAFT COOLING TOWER	REV. NO. 00	DATE : 20.07.2017
		SHEET	OF

ACTUATOR SPECIFICATION & DATA SHEET

VOLUME: V-A**SECTION-III****TECHNICAL SPECIFICATION
FOR
ELECTRIC MOTOR ACTUATORS****1.00.00 SCOPE**

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS-9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 PERFORMANCE

The actuator shall meet the following performance requirements:

- 5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.
- 5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).
- 5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- 5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.
- 5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 SPECIFIC REQUIREMENT**6.01.00 Construction**

- 6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.
- 6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.
- 6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 Motor

- 6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.
 - 6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.
 - 6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.
 - 6.02.04 Motor leads shall be terminated in the limit switch compartment.
 - 6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.
-

-
- 6.02.06 Earthing terminals shall be provided on either side of the motor.
- 6.03.00 **Limit Switches**
- Each actuator shall be provided with following limit switches: -
- 6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.
- 6.03.02 4 end-of-travel limit switches, two for each direction of travel.
- 6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.
- 6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.
- 6.04.00 **Hand Wheel**
- Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutch automatically when the motor is energized.
- 6.05.00 **Position Indicator/Transmitter**
- The actuator shall have:
- 6.05.01 One (1) built-in local position indicator for 0-100% travel.
- 6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.
- 6.06.00 **Space Heater**
- A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.
- 6.07.00 **Wiring**
- All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.
- 6.08.00 **Terminal Box**
- The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.
- 7.00.00 **ACCESSORIES**
-

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

- 7.01.00 One (1) triple pole MCCB
- 7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.
- 7.03.00 One (1) remote-local selector switch.
- 7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.
- 7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 TEST

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 DRAWINGS, DATA & MANUALS

- 9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 To be submitted with Bid

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 To be submitted for Owner / Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed	Motors above 0.2kW upto less than 175kW.
		Fault level 50 kA symm. for 1 sec.	
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed	D.C. alarm, control & protective devices
		Fault level 25* kA. for 1 sec.	

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242

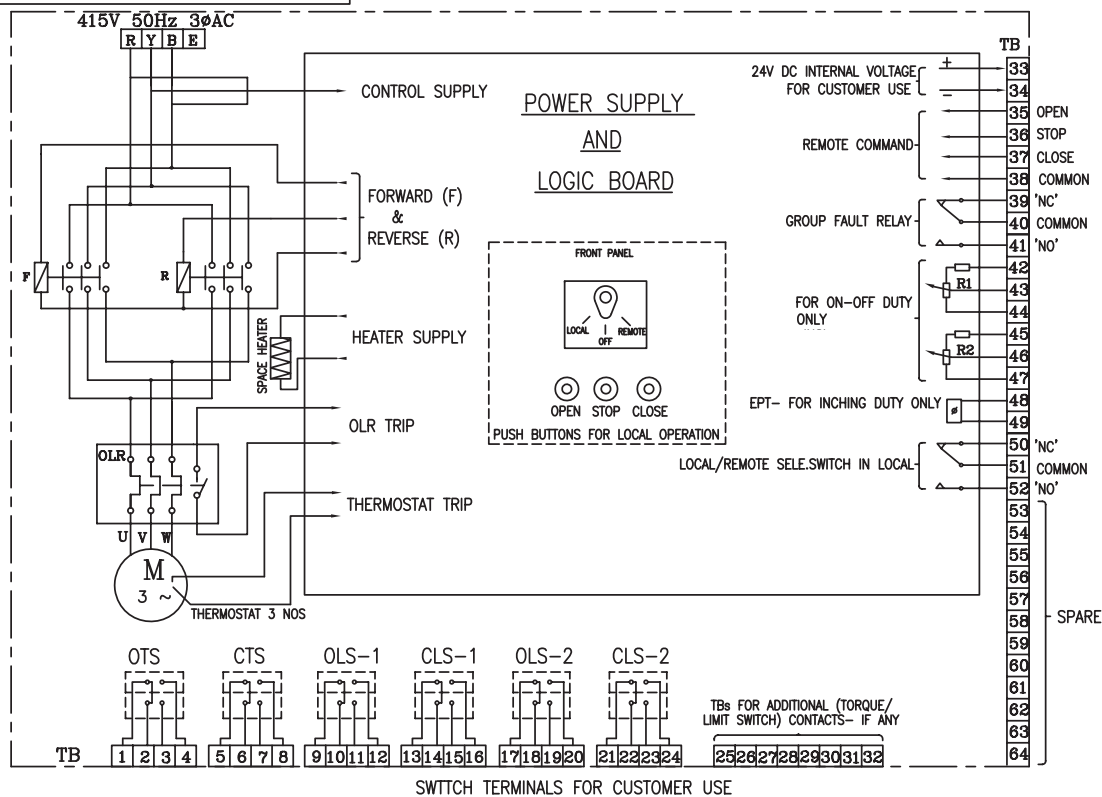
	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME	
			SECTION	
			REV. NO. 00	DATE: 06.01.2015
			SHEET 1	OF 3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	1 x 660 MW BHUSAWAL		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, DUST TIGHT, WEATHER PROOF, SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, IP:65		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR REGULATING SERVICE - 150 STARTS/HR MINIMUM		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE FULL LOAD CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED ☒ DRG. NO. 3-V-MISC-24227 R00 (INDICATIVE)		
	COLOUR SHADE	☒ BLUE (RAL 5012), To be decided during detail engg.		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V (BIDDER TO SPECIFY SINCE INTEGRAL STARTER IS ENVISAGED)		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:		
			VOLUME		
			SECTION		
			REV. NO.	00	DATE: 06.01.2015
			SHEET	2	OF 3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	@ ENCLOSURE CLASS OF MOTOR	☒ IP 65 ☐ FLAME PROOF			
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B			
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ _____			
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	☒ CONTACTORS ☐ THYRISTORS			
	TYPE	☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)			
	IF SMART	NOT APPLICABLE			
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED			
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐			
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC			
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED			
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐			
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED			
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP			
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED			
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED			
	OPEN / CLOSE PB	☒ REQUIRED ☐ NOT REQUIRED			
	STOP PB	☒ REQUIRED ☐ NOT REQUIRED			
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED			
	LOCAL REMOTE S/S	☒ REQUIRED ☐ NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)			
	INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☒ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER		
QUANTITY		☒ 2 Nos. ☐ 3 Nos.			
DRIVING VOLTAGE		☒ 20.5 – 24V DC ☐ _____ V DC			
DRIVING CURRENT		☒ 125mA MAX ☐ _____ mA MAX			
LOAD RESISTANCE		☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	☐ 1 No ☒ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☒ 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

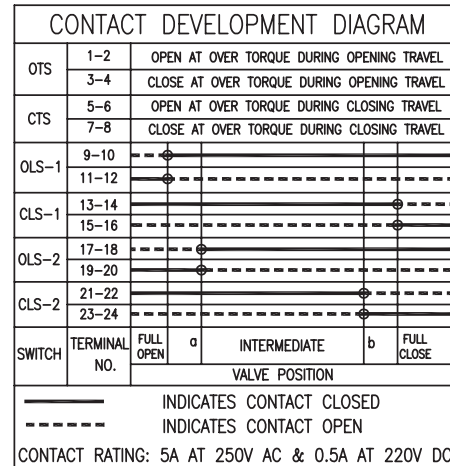
	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:			
			VOLUME			
			SECTION			
			REV. NO.	00	DATE:	06.01.2015
			SHEET	3	OF	3
Data Sheet A & B						
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)			
POSITION TRANSMITTER	POSITION TRANSMITTER	☒ REQUIRED ☐ NOT REQUIRED				
	MFR & MODEL NO.	BIDDER TO SPECIFY				
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS				
	SUPPLY	☒ 24V DC ☐				
	OUTPUT	☒ 4-20mA				
	ACCURACY	$\pm 1\%$ FS				
SPACE HEATER	@SPACE HEATER	REQUIRED				
	@ POWER SUPPLY (NON INTEGRAL)	240V AC, 1 PH., 50 Hz				
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY				
	@ RATING	BIDDER TO SPECIFY				
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED				
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☐ IP 68 @ ☐				
	@ EARTHING TERMINAL	REQUIRED				
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ☒ NOT REQUIRED ☐ 2 NOS. ☐ -----				
CABLE GLANDS	@ POWER CABLE GLAND	SIZE: DURING DETAILED ENGINEERING				
	@ SPACE HEATER CABLE GLAND	SIZE: NOT REQUIRED				
	OTHER CONTROL CABLE GLANDS-1	REFER NOTE &&				
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE:				
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.		
NOTES: 1. SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. 2. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. 4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL, WITH NICKEL COATING SHALL BE PROVIDED. 5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE. 6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. 7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS. && INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PX0.5 SQMM - ONE CABLE GLAND OF OD SIZE 20 MM AND FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PX0.5 SQMM AND 2ND 2PX0.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.						
NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL NAME SIGNATURE DATE		

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

3-V-MISC-24227
DRAWING NO.

INDICATIVE DRAWING



SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

- CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

- ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
- ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER
- R1-R2-POTENTIOMETER 2 x 100 OHMS
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3 ϕ 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
OR NAME OF
CUSTOMER/PROJECT (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

 365-121	NAME	SIGN	DATE	NO. OF
	N.P.ESWAR	N.P.	07.10.04	VAR.
	D.DINAKARAN	D.D.	07.10.04	
	K.ARUNACHALAM	K.A.	07.10.04	

DEPT	VL	SCALE	WEIGHT (KG).	REFERENCE INFORMATION	NO. OF
CODE					TRIAL
TITLE	WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER			DRAWING NO. 3-V-MISC-24227	REV 0

	1X660 MW BHUSAWAL TPP CONTROL & INSTRUMENTATION Technical specification for NATURAL DRAFT COOLING TOWER	SPEC NO.: PE-TS-415-145-IXXX	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE : 20.07.2017
		SHEET	OF

SPECIFICATION AND DATA SHEET FOR LOCAL CONTROL PANEL

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM PROJECT: 1 x 660 MW BHUSAWAL TPS	DRAWING NO:	
		REV. NO. 00	DATE:
		SHEET 1	OF 2

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Introduction- Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.

The system shall normally have 2 pumps. The measuring instruments recommended are level switches (float/displacer type) for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the Customer.

The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

CONTROL WRITEUP

The operation of Sump pumps (fixed and portable type) shall be as follows:

Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.

Controls philosophy

CONTROLS

- (a) Start/stop facility for each pump from LCP.
- (b) Selector switch for main/standby selection.
- (c) Auto/Manual selector switch for each pump.

AUTO START/STOP

- a) One number level switch (high level) provided in the sump shall start one number sump pump in the event of high water level in the sump.
- b) One number level switch (very high level) provided in the sump shall start second sump pump in the event of very high water level in the sump.
- c) One number level switch (low level) provided in the sump shall stop the running pumps in the event of low water level in the sump.
- d) If any of the working sump pumps trips the standby sump pump will come into operation automatically provided the very low level signal is not present.

Indications

- a) Sump pumps status (ON/Off/Trip).
- b) Level indications(Low,High,V.High)

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM PROJECT: 1 x 660 MW BHUSAWAL TPS	DRAWING NO:	
		REV. NO. 00	DATE:
		SHEET 2	OF 2

General requirements for measuring instruments

Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experience manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/ numbers as approved by BHEL during detailed engineering.

1. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a ground terminal and shall be suitably connected to panel grounding bus.
2. The necessary root valves, impulse pipings and all the other accessories required for mounting/erection of local instruments shall be furnished even if not specifically asked for.
3. Instruments shall be terminated up to LCP with control cable (1.5sqmm). The LCP shall be fully wired. All the necessary cables, flexible conduits, junction boxes and accessories for the above purpose shall be included.

	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
LOCAL PANEL		

1.00.00	GENERAL REQUIREMENT
1.01.00	ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT
1.01.01	All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.
1.02.00	SURFACE PREPARATION & PAINTING
1.02.01	All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.
1.02.02	Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.
1.02.03	Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades: • Exterior – Opaline green shade 275 of IS: 5 or equivalent international code.. • Interior - Brilliant White.
1.02.04	Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.
1.03.00	WIRING
1.03.01	All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.
1.03.02	Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.
1.03.03	All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

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- 1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.
- 1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices
- 1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- 1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.
- 1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.
- 1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- 1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.
- 1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.
- 1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.
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1.04.00	TERMINAL BLOCKS
1.04.01	All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.
1.04.02	All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.
1.04.03	The characteristics of the terminal blocks shall be as follows. i) High contact force, independent of conductor cross-section and large contact surface area. ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point. iii) Inspection and maintenance free (resistant to thermal aging and vibration) iv) Low and constant voltage drop
1.04.04	The insulation of the terminal blocks shall be of suitable thermoplastic material.
1.04.05	The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.
1.04.06	Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.
1.04.07	Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.
1.04.08	At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

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- 1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.
- 1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.
- 1.04.11 Other requirements of the terminal blocks are as follows:
- i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
 - ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
 - iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
 - iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
 - v) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- 1.05.00 **GROUNDING**
- 1.05.01 Separate Protective and Electronic system ground as required shall be provided.
- 1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.
- 1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.
- 2.00.00 **CONTROL DESKS & PANELS**
- 2.01.00 **GENERAL**
- 2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &
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	accessories as required for completeness of the system.
2.01.02	The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.
2.01.03	The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.
2.01.04	Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.
2.01.05	For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.
2.01.06	Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
2.01.07	Nameplate a) Nameplate shall be provided for instrument or device mounted on the panel. b) Nameplates for panels shall be provided both in front and rear.
2.02.00	CONTROL DESK
2.02.01	Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.
2.02.02	Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.
2.02.03	Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.
2.02.04	Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

- 2.02.05 Design shall include Earthing bolts.
- 2.02.06 Back installed items shall be suitably concealed from front view.
- 2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.
- 2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)
- Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.
- 2.03.00 BACK UP PANEL
- 2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.
- 2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.
- 2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.
- 2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also
-

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Coal Annealed (CRCA) steel sheet
2.	Thickness of Sheet	:	a) 2.0 mm for faces supporting instruments / terminals
		:	b) 1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards
4.	Post welding operation	:	a) Grounding of all welds to smoothness
		:	b) Rounding of corners
-

-
	:	c) Cleaning of weld spatters
5. Panel height	:	2300 mm (approx)
6. Corners	:	7 mm inner radius
7. Dimensional Tolerances	:	a) In height & length - 3 mm
		b) In height between adjacent sections - 2 mm
		c) Total for a group - 6 mm
8. Doors	:	Double, recessed, turned back edges, full height front & rear
i) Thickness of Sheet	:	2 mm
ii) Hinges	:	Stainless steel
iii) Door latches	:	Three point type
iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure
v) Opening of the doors	:	Outward
vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof
9. Gland plates	:	Removable in sections 4 mm thick (bottom)
10. Cable entry	:	Bottom
11. Hardware	:	a) Anti vibration pad- 15 mm
		b) Predrilled base channel ISMC – 100 or equivalent for all sides
		c) Stainless steel buff- finished 2 mm thick kick plate for all sides
		d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
		e) Rubber strips to ensure air
-

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

Door switch, lamps, thermostat,
h) heaters and industrial grade cooling fans,, illumination fixtures

12. Name Plate : Both at front and back surface of the panel

13. Fixing of name plate : Stainless steel pan head screws

14. Name plate material : Laminated phenolic (3 layers)

15. Lettering : Black with white engraved

16. Mounting of terminal blocks : Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1. Type of Enclosure : Dust tight & weatherproof conforming to IP 65
2. Material : 3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3. Type of Cover : Solid unhinged with retention chain / Screwed at all four corners
4. Paint :
 - i) Exterior : Opaline green shade 275 of IS: 5
 - ii) Interior - Brilliant Glossy White.

		Surface / Two (2) inch Pipe stanchion
5.	Mounting	: (At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	: 3 mm (min) Bottom / side Gland plate
7.	Gasket	: Neoprene
8.	Grounding	: Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	: Two at bottom capped
10.	Identification	: Label for JB and Tags for cable
11.	Accessories	: Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals a) conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.
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SPECIFICATION FOR LOCAL PANELS

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1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel

Frame thickness: Not less than 3.0mm

Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others

Gland plate thickness: 3.0mm

Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm. The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

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3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function. The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm² size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5mm² external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

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3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System
It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays
The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers
The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches
Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.

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Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

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5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels	:	Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels	:	Data sheet no. PES-145A-DS2-0

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.:	
				VOLUME	
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				REV. NO.	DATE:
				SHEET 1 OF 1	
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0		
Data Sheet A & B					
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL	MANUFACTURER				
	CONSTRUCTION		☐ FOLDED ☒ WELDED (CRCA) (As per requirement)		
	ENCLOSURE SHEET THICKNESS	FRONT	☒ 2.0 mm		
		OTHER	☒ 2.0 mm		
DOOR		☒ 2.0 mm			
TECHNICAL	INPUT POWER SUPPLY		☐ 240V 50 Hz AC ☐ 220V DC ☒ 415V 3 PHASE		
	NO. OF FEEDERS		☐ ONE ☒ TWO		
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☒ During detailed engg. (As per requirement)		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		AS REQUIRED		
	PAINT TYPE		☐ EPOXY ENAMEL ☒ EPOXY POWDER COATED		
	PANEL COLOUR (EXTERNAL)		☒ Exterior- Opaline green shade 275 of IS: 5 or equivalent international code ☒ Interior- Brilliant White (To be finalized during detailed engineering.)		
	FINISH		☒ MATT ☐ GLOSSY ☐ SEMI GLOSSY		
	PANEL COLOUR (INTERNAL)		☒ BRILLIANT WHITE ☐ CREAM ☐ OFF WHITE		
	FINISH		☐ MATT ☐ GLOSSY ☒ SEMI GLOSSY		
	CLASS OF PROTECTION		☒ IP-42 ☐ IP-65		
	CONTROL HARDWARE		☒ RELAY BASED		
	FOUNDATION ARRANGEMENT		☒ FOUNDATION BOLTS ☐ ANCHOR FASTENERS		
	WEIGHT OF PANEL (Kg.)		BIDDER TO SPECIFY		
	PANEL TYPE		☐ PRESSURISED ☒ UNPRESSURISED As per Requirement		
	CABLE GLAND		☐ SINGLE COMPRESSION ☒ DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT)		☐ 1 Amp CT ☐ 4-20 mA As per Requirement		
	NAME SIGNATURE DATE	PREPARED BY		CHECKED BY	
					COMPANY SEAL
					NAME
					SIGNATURE
					DATE

	DATA SHEET FOR LOCAL PANELS		SPECIFICATION NO.:	
			VOLUME	
			SECTION	
			REV. NO.	DATE:
			SHEET 1	OF 1
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0	
Data Sheet C				
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)				
GENERAL	MANUFACTURER			
	CONSTRUCTION			
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
DOOR				
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH			
	PANEL COLOUR (INTERNAL)			
	FINISH			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			
	PANEL TYPE			
	CABLE GLAND			
	AAMETER (TYPE OF INPUT)			
NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME SIGNATURE DATE

	1X660 MW BHUSAWAL TPP	SPEC NO.: PE-TS-415-145-IXXX	
	CONTROL & INSTRUMENTATION	VOLUME	
	Technical specification for	SECTION	
	NATURAL DRAFT COOLING TOWER	REV. NO. 00	DATE : 20.07.2017
	SHEET OF		

QAP FOR LOCAL CONTROL PANEL

 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL						STD QUALITY PLAN NO.: PE-QP-999-145-I056					
								VOLUME		IIB			
								SECTION		D			
								REV. NO.		01		DATE: 22-02-2008	
								SHEET		1		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^s			Remarks	
									P	W	V		
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2		
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---		
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---		
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---		
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1		
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---		
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---		
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1		
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---		
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---		

LEGEND: *	CR - Critical characteristics	\$	P - Agency Performing the Test.	1 - BHEL
	MA - Major characteristics		W - Agency Witnessing the Test.	2 - Vendor
	MI - Minor characteristics		V - Agency Verifying the Test.	3 - Sub-vendor



PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.: PE-QP-999-145-I056

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type 2. Verification of Test Certificates 3. Operation / Functional check 4. I.R. 5. H.V. 6. Calibration 7. Pick up / Drop off Voltage	CR CR CR MA MA MA MA	Visual Scrutiny of Type / Routine T.Cs. Electrical Electrical Electrical Electrical	Sample 100% Sample+ 100% 100% 100% 100% 100%	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	BHEL Spec. and BOM Relevant IS Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue Relevant Indian Std & Catalogue	Log Book Log Book Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2 2 2	--- --- --- --- --- --- ---	--- --- --- --- --- 1 ---	+ for relay & contactors only @ for all components except relays & contactors.

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 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL							STD QUALITY PLAN NO.: PE-QP-999-145-I056			
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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 PEM :: C&I		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL						STD QUALITY PLAN NO.: PE-QP-999-145-I056					
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^s			Remarks	
									P	W	V		
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---		
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---		
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---		
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1		
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1		
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---		
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---		
12.	FINAL Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.	
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1		
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1		

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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	1X660 MW BHUSAVAL TPP CONTROL & INSTRUMENTATION Technical specification for NATURAL DRAFT COOLING TOWER	SPEC NO.: PE-TS-415-145-IXXX	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE : 20.07.2017
		SHEET	OF

KKS NO. PHILOSOPHY



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

1 x 660 MW BHUSAWAL TPS

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

1 x 660 MW BHUSAVAL TPS

ANNEXURE-1**List of System / Sub-System Codes used in Power Plant:**

- 1) Mill Reject Handling System: EUA

ANNEXURE-2**Standard Equipment Codes:**

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level

	DOCUMENT TITLE
	KKS NUMBERING PHILOSOPHY
	1 x 660 MW BHUSAWAL TPS

CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

- i) Use 10, 20, 30... To distinguish between main systems having same Alpha Codes. Examples:
 - a) Main Steam (Left) and Main Steam (Right)
 - b) BFP – A/B/C
 - c) ID Fan – A/B, FD Fan A/B, AH – A/B
- ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.
- iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

i) Valves and Dampers --- Equipment Code – AA

		<u>N1</u>	<u>N2 N3</u>
Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyristor Control</i>)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

	DOCUMENT TITLE		
	KKS NUMBERING PHILOSOPHY		
	1 x 660 MW BHUSAWAL TPS		
	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99
ii) Field Instruments			
Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			
Example of Numerical Key Usage:			
In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ... Where system code is same.			

	TITLE: TECHNICAL SPECIFICATION NATRURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS SPECIFIC TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: I
		SUB-SECTION: ID
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION – ID

DATASHEET-A

	TITLE DATA SHEET-A NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-415-165-N002	
			VOLUME : ...	
			SECTION : ...	
			REV. NO. 0	DATE 06.11.2018
			SHEET 1	OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
1.0	Type Model No.		NATURAL DRAUGHT COOLING TOWER
2.0	Quantity	Nos//Unit	ONE
3.0	Rated Capacity	M ³ /Hr	74,000
4.0	Design Wet Bulb Temperature	°C	27
5.0	Cold Water Temperature	°C	32
6.0	Cooling Tower Approach	°C	5
7.0	Cooling Tower Range	°C	10
8.0	Cooling Tower Loss		
	a. Evaporation Loss		1237.488437 m3/hr
	b. Drift Loss		7.4 m3/hr
	c. Blow Down Loss (Concentration Factor to be indicated)		302 m3/hr @ COC = 5
9.0	Total Differential Pressure Drop (Considering recovery)		
	a. Drop through Louvers (up to bottom of fill)	mm of H ₂ O	1.6697
	b. Drop through Fills	mm of H ₂ O	1.6834
	c. Drop through Eliminators (distribution)	mm of H ₂ O	0.3287
	d. Velocity Pressure - Other Phenomena	mm of H ₂ O	0.380
	e. Drop through plenum Throat	mm of H ₂ O	0.3157

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004/02	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
			SHEET 2	OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
10.0	Basin Storage Capacity	M ³	_____
11.0	Plan Dimensions (Diameter)	M	_____
12.0	Overall Size of Cooling Tower (Plan Dimensions X Height)	MXM	_____
13.0	Required Pumping Head including all losses measured from Terminal Point	M	_____
14.0	Cooling Tower Levels		
	a. Graded Level	M	_____
	b. Maximum Water Level	M	_____
	c. Basin Curb Level	M	_____
	d. Minimum Water Level	M	_____
	e. Basin Bottom Level	M	_____
15.0	Overall Tower Height from Basin Floor	M	_____
16.0	Basin Dimensions		
	a. Diameter	M	_____
	b. Depth (from Basin Curb)	M	_____
17.0	Free Board (Above Max. Water Level)	mm	_____
18.0	Heat Transfer Data	mm	
	a. Heat Transfer Coefficient (K)		_____
	b. Tower Coefficient © Ka V/L	M	_____
	c. Average Fill Height	M	_____
	d. Total Fill Volume	M ³	_____

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004 02	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
			SHEET 3	OF 9
SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER	
	e. Total Tower Wetted Surface	M ²		
19.0	Hot Water Distribution Piping			
	a. Size (OD X Thk)	Mm X mm		
	b. Elevation of Center Line of Hot Water distribution Header	M		
	c. Design pressure for Hot Water Distribution System	Kg/cm ² (g)		
20.0	Isolation Valves in Hot Water Risers			
	a. Size	mm		
	b. Quantity			
	c. Type/Code & Standard		04	
	d. Make			
	e. Pressure drop across the valve in fully open position			
	f. Materials of Construction			
	i) Body			
	ii) Disc			
	iii) Drive Shaft/Stub Shaft			
	iv) Bearings			
21.0	Flow Control Valves (If Applicable)			
	a. Size	mm		
	b. Quantity			
	c. Type			
	d. Make			

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004 02	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
			SHEET 4	OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	f. Materials of Construction		
	i) Body		
	ii) Spindle		
	iii) Trim		
22.0	Isolating Valve in Sludge Pit		
	a. Size	mm	
	b. Quantity		
	c. Type		
	d. Make		
	e. Conform to which code in respect of design/testing		
	f. Materials of Construction		
	i) Body		
	ii) Stem		
	iii) Trim		
23.0	Stationary Screen		
	a. Quantity		
	b. Size & Material of Bar		
	c. Clear Space between the bar		
	d. Lifting Arrangement		JLLEY
24.0	Fill & Fill Supports		
	a. Type of fill		
	b. Material		
	c. Expected Life	Years	

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004 J2	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
			SHEET 5	OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
d.	Arrangement of Fill		
e.	Method to prevent dislocation of Fills	Years	
f.	Type/Material/Size of fixing arrangement to supporting grid		
g.	Fill Support Grids		
	i) Type		
	ii) Material (give full specification)		
	iii) Size		
h.	Grid Supporting Frames		
	i) Type		
	ii) Material (give full specification)		
	iii) Size		
i.	Fasteners		
	i) Type		
	ii) Fill/Splash Bars		
	iii) Fill Support Grids		
	iv) Frames for Supporting the Grids		
25.0	Drift Eliminators		
a.	Number of Passes		
b.	Gross Face Area per pass	M ²	
c.	Type		
d.	Eliminator Blades	mm	
	i) Material		
	ii) Maximum Length of blade		
	iii) Size and shape of blades		
	iv) Type and material of drain boards		

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004102	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
		SHEET 6	OF 9	

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
e.	Blade Support Spacers		
i)	Type		
ii)	Material		
f.	Support for Spacers		
i)	Type		
ii)	Material		
g.	Fasteners		
i)	Type		
ii)	Material		
26.0	Gate in Cold Water Outlet Channel		
a.	Number per cold water outlet channel		
b.	Gate Type		
c.	Name of Manufacturer		
d.	Gate Size		
e.	Weight of each gate		
f.	Are elements of gate dismantling type?		
g.	Weight of each Element		
h.	Frame Type		
i.	Fixing arrangement of frame with RCC channel		
j.	Lifting Arrangement of Gate		

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004 J2	
			VOLUME : III	
			SECTION : A	
			REV. NO. 0	DATE 22.03.2003
			SHEET 7	OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	k. Expected Life	Years	
27.0	Sludge Pump & Motor		
	a. Pump Type		
	b. Make & Model No.		IERV
	c. Capacity	M ³ /Hr	
	d. TDH	MWC	
	e. Pump Speed	RPM	
	f. Pump Efficiency at Rated Flow		
	g. Power Consumption at Rated Flow	KW	
	h. Material of Construction		
	i) Impeller		
	ii) Casing		
	iii) Pump & Line Shaft		
	iv) Bearings		
	v) Impeller/Casing Wearing Rings		
28.0	Cooling Tower Materials of Construction		
	a. Casing		
	b. Louvers		
	c. Partition Walls		
	d. Basin Partition Walls		
	e. Stack		
	f. Stair Case		
	g. Hot Water piping		

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-999-165-N004 J2	
			VOLUME : III	
			SECTION : A	
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SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	h. Hot Water distribution basin		
	i. Internal Walkways		
	j. Supporting Structure		
	k. Hand Rails		
	l. Structure Connector		
	m. Bolts, nuts, washers and other hardware		
	n. Nails		
	o. Anchor Bolts		
	p. Hot Water Distribution Nozzle		
	q. Hot Water distribution Plates		
	r. Spacers		
	s. Mechanical Equipment Support		
29.0	Weight of Equipments		
	a. Weight of Heaviest part to be handled	Kgs.	
	b. Size of largest part to be handled	Kgs	
30.0	Inspection & Testing		
	a. Hydro Test Pressure for Hot water piping		
	i) Test Pressure	Kg/cm ² (g)	
	ii) Duration	Minutes	

	TITLE DATA SHEET-B NATURAL DRAFT COOLING TOWER		SPECIFICATION NO.: PE-TS-415-165-N002	
			VOLUME : ...	
			SECTION : ...	
			REV. NO. 0	DATE 06.11.2018
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SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
31.0	Painting Details		
a.	Externally painted Surfaces		
		External Surface	Surface Preparation
			Primer
			Final Paint
i.	Piping (Under Ground)		and Blasting
			4 mm thk. Coal Tar Tape as per AWWA C-203: 2002/IS-15337:2003
ii.	Piping (Over Ground)		-- do --
			1 Coat of Coal Tar
iii.	Stationary Screens		
			2 Coats of Enamel Finish Paint
iv.	Hoist Derric		
v.	Other Items		
a.	Internally painted Surfaces		
		Internal Surface	Surface Preparation
			Primer
			Final Paint
i.	Piping and Valves		and Blasting
			2 coats of Epoxy Resin based Red Oxide Primer (Total 140 micron DFT)Primer
ii.	Other Items		
			2 to 3 Coats of Coat tar Epoxy Paint
32.0	Maximum Water Handling capacity	M ³ /Hr	74,000 (design)
33.0	Cooling Water Flow Rate (L)	Kg/m ² /Hr	7126.917887
34.0	Dry Air Flow Rate (G)	Kg/m ² /Hr	3655.893913
35.0	Ratio of Water to Air (L/G)		1.949
36.0	Dry Air Flow	Kg/Hr	37,959,768
37.0	Temperature of air leaving the Stack	°C	40.43
38.0	Inlet air Enthalpy	KCal/Kg	20.309
39.0	Exit air Enthalpy	KCal/Kg	
40.0	Total Heat Exchange/Kg of Inlet Dry air	KCal/Kg	
41.0	Losses in hot water piping in MWC	MWC	
42.0	Type of air inlet	MWC	

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS STANDARD TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: II
		SUB-SECTION: IIA
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION - IIA

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR CT

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWERS	SPECIFICATION NO. PE-TS-999-165-N004	
		VOLUME : II B	
		SECTION : D Part-A	
		REV. NO. 0	DATE : 22.03.2003
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1.0

GENERAL:

1.1

This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing requirements for transportation, erection, commissioning and testing at site of all materials and equipments inclusive of complete electrical and civil works for the Natural Draft Cooling Tower complete with all accessories as specified hereinafter.

2.0

CODES AND STANDARD:

2.1

The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

a)

Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.

b)

PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.

c)

For Electrical, Civil Codes/ Standards refer respective Specification.

d)

BS-4485 – Specification for Water Cooling Tower.

2.2

In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.0

DESIGN REQUIREMENTS:

3.1

The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

3.2

All the components shall be capable of safe, proper and continuous operation at all cooling water flows up to and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

3.3

The cooling tower shall be Natural Draft cross flow/ counter flow type as per enclosed Data Sheet-A.

3.4

The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.

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3.5	The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.		
3.6	The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.		
3.7	The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.		
4.0	CONSTRUCTIONAL FEATURES:		
4.1	Casing and Louver (If required):		
4.1.1	The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.		
4.1.2	The louvers and casing shall be made of material as specified in the Data Sheet-A.		
4.2	Partitions:		
4.2.1	Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.		
4.3	Fill:		
4.3.1	Cooling tower fills type and material shall be as specified in Data Sheet-A.		
4.3.2	Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.		
4.4	Fill Supports:		
4.4.1	Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.		
4.5	Drift Eliminations:		
4.5.1	Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.		
4.5.2	The eliminator frame shall be of rugged construction and shall be firmly secured to the structural		

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frame to arrest vibration. Suitable access to the eliminator frame work from the basin should be provided for any maintenance or physical replacement of eliminator blades etc., when the particular cell is taken out for maintenance.			
4.6 Hot Water Distribution System:			
4.6.1 Motorised/Manual valves (as indicated in Data sheet A) shall be provided in the hot water distribution piping such that each section can be isolated without affecting the operation of other section.			
4.6.2 The pipes and valves in hot water distribution system shall be designed to take care of the possible thermal stresses due to temperature variation. This could be achieved by providing sliding supports for supporting all the pipes fabricated from carbon steel.			
4.6.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.			
4.7 Cold Water Basin:			
4.7.1 The cooling tower basin shall be constructed in RCC (unless otherwise specified in Data Sheet-A). The capacity of the cooling tower basin shall be as indicated in Data Sheet-A.			
4.7.2 The cold water basin shall be partitioned into two chambers or as specified in Data Sheet-A. The two sections of the Cooling Tower basin should be separate water tight compartments, which can be isolated one at a time for cleaning/maintenance purposes.			
4.7.3 Sludge pits with isolating valves and spool pipe having flanged ends shall be provided for individual basin chamber for connection to drainage pipe.			
4.7.4 For each basin chamber, there shall be a cold-water outlet channel. In the connection between basin chamber and cold water outlet channel there shall be a stationary coarse bar screen and gate in the absence of any specific preference under Data Sheet-A.			
4.7.5 Each basin chamber shall have an overflow arrangement and scouring arrangement.			
4.8 Submersible sludge Pumps:			
4.8.1 The submersible type sludge pumps complete with electric motors, discharge side valves, piping, supports, hangers and clamps etc. shall be supplied at the option of the purchaser for each cooling tower for basin draining/ desludging. The quantity, design parameters and the materials of construction of the vertical sludge pumps shall be as per Data Sheet-A. Each pump shall be non-clog type, self water lubricated. The vertical sludge pumps shall be treated as an optional item and are to be offered if asked for in the Data Sheet-A enclosed to this specification.			

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4.9.0

Screens & Gates in Cold Water outlet Chamber:

4.9.1

The screens shall be vertical stationary type; the opening size and the mesh aperture shall be as per Data Sheet-A. The guides for the screens to be embedded in the concrete shall be of material as per Data Sheet-A.

Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

4.9.2

For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and trolley for mounting the hoist shall be furnished. The chain pulley hoist shall be manually operated and shall conform to IS-3832 class-II.

4.9.3

The gates fixed in vertical sections in cold water outlet chamber shall be as per standard practice and quality, material and type shall be as given in Data Sheet-A.

4.9.4

The isolating valves on the scour lines within the sludge pits shall conform to class I of IS-780 and shall be of reputed make.

4.10

Hardware:

4.10.1

All nails and fastening bolts, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel 304, all others nuts & bolts etc. shall be made of HDG steel.

4.11.0

Access:

4.11.1

Two R.C.C. staircases for approach to the hot water distribution level

4.11.2

Doors for entrance into Cooling Tower Distribution level shall be provided as specified in Data Sheet -A.

4.11.3

Two external ladders for approach to top of cooling tower from water distribution level.

4.11.4

Access/platforms for inspection and maintenance of hot water distribution system along with spray nozzles.

4.11.5

Suitable arrangement for supporting walkways inside the cooling tower shall be made and loading of such arrangement shall be independent of the fill material.

4.11.6

Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hot dip galvanised after fabrication.

5.0

INSPECTION AND TESTING:

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5.1	The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.	
5.2	Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.	
6.0	TEST AT SITE:	
6.1	The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.	
6.2	The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower.	
	The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.	
6.3	Necessary correction curves required for correcting the test results for any difference in test and guaranteed design condition shall be furnished by the supplier for approval along with the proposed test procedure.	
6.4	All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.	
7.0	PERFORMANCE GUARANTEE, TOLERANCE & PENALTIES:	
7.1	Each equipment shall be guaranteed to meet the performance requirement as specified.	
7.2	The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.	
7.3	The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.	
7.4	The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,	

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cooling range, water loading of the tower.

7.5 The vendor shall guarantee the performance of the whole cooling tower plant to meet the specifications when tested in accordance with cooling tower institute acceptance test code ATP-105, performance curves as per ATP-105 shall be furnished by the vendor.

7.6 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved, then for every increase of 0.5 degree C or part thereof in the cold water temperature over design conditions, a sum as specified in data Sheet-A shall be paid by vendor to the purchaser for shortfall of guarantee, for the cooling tower.

7.6.1 In case the cold water temperature exceeds the acceptable limits of purchaser, the whole plant will be rejected and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

8.1 All equipment shall be neatly finished. All exposed metal/ concrete/ wooden surface shall be smooth and free from burrs/ projections.

The metal surfaces to be painted should be accessible, suitable for priming and affording maximum protection throughout the life of the plant. The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I) and shall include the following:

a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).

b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).

c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

8.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS:

8.2.1 The inside surfaces of the piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer. The thickness of cured coating shall be as specified in Data Sheet-A.

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.

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8.3.2	Coating/ wrapping/ concrete lining as specified in Data Sheet-A.		
8.4	Outside Surface or Piping (Exposed):		
8.4.1	Surface treatment as specified in Data Sheet-A.		
8.4.2	One coat of red oxide primer.		
8.4.3	Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.		
8.5	All steel parts used for cooling tower construction shall be hot dip galvanised as per IS-4736 after shop fabrication. The external surfaces of the flow regulating valves access platform, access door and also the hoisting derrick subjected to hot water fumes shall also be thoroughly cleaned and treated and shall be coated with rust preventing paints.		
8.6	All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.		
8.7	The external and internal surfaces of the tower shall also be painted.		
9.0	DRAWING AND DATA AFTER AWARD OF CONTRACT:		
	The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.		
10.0	SPECIAL TOOLS & TACKLES:		
	Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.		

	TITLE : DATA SHEET – C FOR NATURAL DRAFT COOLING TOWERS	SPECIFICATION NO. PE-TS-999-165-N004	
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DATA / DOCUMENTS TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

1. General Arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions limits of scope of supply of piping, limits of civil works included, showing extent of platforms, walk ways, handrails, access doors staircase, end wall derrick etc. and the limits of scope of supply of electrical works.
2. General Arrangement drawing of Cooling Tower basin indicating overflow and desludging arrangement.
3. General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower.
 - a) Tower fill with supporting arrangement.
 - b) Drift eliminator installation and details.
 - c) Complete hot water distribution system including flow regulating valves, distribution basin/ pipes and nozzles etc.
4. Arrangement drawing of the cold water outlet chambers and sludge pits incorporating also the arrangement of screens, gates, valves and piping terminal details.
5. Cooling tower performance curves showing wet bulb temperature V/s. cold water temperature for design cooling range, 90% cooling range and 110% cooling range at 90% ,100% and 110% of design flow.
6. Detailed GA and sectional assembly drawing of BF valves in hot water risers indicating materials of construction of various components.
7. General Arrangement and cross-sectional assembly drawings of sludge pumps and motor drives along with their performance curves.
8. Electrical drawings and data.
 - i) Cable Schedule
 - ii) Cable tray and trench layout.
 - iii) Drawing on illumination system of cooling tower structure including wiring diagram showing conductor and conduct sizes and design calculation.
 - iv) Drawing on Aviation Obstruction Lighting System.
 - v) Drawing on grounding system inclusive of lightning protection system.

	TITILE DATA SHEET – C FOR NATURAL DRAFT COOLING TOWERS	SPECIFICATION NO. PE-TS-999-165-N004	
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vi) Drawing of lighting sub-distribution board & junction boxes.

10. Drawings, data and calculation on civil works :

- i) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of cooling towers inclusive of prestressed concrete fill where applicable. All civil and structural design calculations shall be furnished by the supplier for approval of the purchaser.
- ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.
- iii) Civil drawings for cold water basin, sludge sumps, connecting channels, partitions, louvers, end walls, longitudinal beams, hot water distribution basin, its covering, staircase, platforms, cable trenches, etc. all complete.
- iv) Bar bending details for all reinforced concrete structures.
- v) Insert details, anchor bolt details.
- vi) Final painting schedule.
- vii) Other drawings & data as necessary.

11. Test procedure along with details of tests to be conducted for the offered cooling tower.

12. Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.

13. Operation and Maintenance Manuals

14. Field Quality Plan for site activities – viz. Civil works & Erection.

15. Cooling tower performance test procedure.

	QUALITY PLAN		CUSTOMER:			PROJECT:				SPEC. NO :	
			BIDDER/VENDOR			QP NO.PE-QP-999-100-M004		REV. 00 DT.31.03.99		SPEC. TITLE	
	SHEET 1 OF 3		SYSTEM POWER CYCLE/ LP VALVES			ITEM: GATE/ GLOBE VALVE				SECTION VOLUME	
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE- GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V		REMARKS

1.0	MATERIALS											
1.1	BODY,BONNET, YOKE,WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. PHYS,CHEM,PROPS	MA	PHYS,CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH.SPEC.	APPD. DRG./ TECH.SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
		2. HEAT TREATMENT	MA	REVIEW OF H.T. CHART	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA	VISUAL	100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	2,1	-	FILM REVIEW BY BHEL
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH., ELEC. TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334	INSPN. REPORT	3	2,1	1 *	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. TRAVEL/STROKE	MA									
		3. TRAVEL TIME	MA									
		4. OPERATION OF LIMIT SWITCH	MA									
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA									
		7. IR,HV,IR	MA									
		8.DEGREE OF PROTECTION	MA	WATER, DUST TEST	1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		
			BIDDER'S/ VENDOR'S COMPANY SEAL

	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2,1	1*	
		3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE P.T	100%	-DO-	-DO-	INSPN. REPORT	3	2,1	1*	
2.0	SS/STELLITE DEPOSIT ON DISC / BODY SEAT/BACK SEAT	1. SURFACE DEFECTS	CR		100%	ASTME:165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2,1	2,1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.0	IN-PROCESS INSPECTION											
3.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS.,VISUAL	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.2	WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP. DRG./ ANSI B16.34	TEST CERT.	3/2	-	2,1	
3.3	SPINDLE, BODY SEAT RING, WEDGE/DISC, BACK SEAT	1. SURFACE DEFECTS	CR	P.T.	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
3.4	WEDGE/DISC & SEAT RING, SPINDLE AND BACK SEAT	1. LAPPING	CR	BLUE MATCHING	100%	UNIFORM CONTACT	METAL TO METAL	INSPN. REPORT	3/2	-	2,1	
4.0	ASSEMBLY	1. DIMENSIONS 2. WEAR TRAVEL	MA MA	MEAS. MEAS.	100% 100%	APPD.DRG. -DO-	APPD.DRG. -DO-	-DO- -DO-	3/2 3/2	2,1 2,1	- -	FOR GATE VALVES ONLY
5.0	TESTING	3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
5.1	BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
		2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	-DO	-DO-	-DO-	3/2	2.1	-	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO	-DO-	-DO-	3/2	2.1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		
			BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN			CUSTOMER:			PROJECT:				SPEC. NO :	
				BIDDER/VENDOR			QP NO.PE-QP-999-100-M004		REV. 00 DT.31.03.99		SPEC. TITLE	
	SHEET 3 OF 3		SYSTEM POWER CYCLE/ LP VALVES			ITEM: GATE/ GLOBE VALVE			SECTION VOLUME			
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE- GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V		REMARKS	

5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR OPERATION AL TESTING	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2.1	-	
5.3	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-	
	2.MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-	
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-	
6.0	COMPLETE VALVES END CONNECTION DETAILS	1. OVERALL DIMENSION	MA	MEAS	SAMPLE	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-	
7.0		1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG. / RELV.STD	APPD. DRG. / RELV.STD	-DO-	3/2	2,1	-	
		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1	
9.0	PAINTING	1. SURFACE PREPARATION	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1	
		2. UNIFORMITY & THICKNESS	MI	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	2	1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1	

ABBREVIATIONS**CR = CRITICAL CHARACTERISTIC****MA =MAJOR CHARACTERISTIC****MI = MINOR CHARACTERISTIC****P = PERFORMED BY****1 = PURCHASER (BHEL)****W = WITNESSED BY****2 = VENDOR****V = VERIFIED BY****3 = SUB VENDOR OF THE VENDOR**

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		
			BIDDER'S/ VENDOR'S COMPANY SEAL



QUALITY PLAN

SHEET 1 OF 3

CUSTOMER :

BIDDER/VENDOR

SYSTEM:

PROJECT :

QP NO. PE-QP-999-100-MO41

REV.00 DT. 31.03.99

ITEM: PIPES & FITTINGS

SPEC. NO

VOLUME: II-B

SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V			REMARKS
1.0.0	MATERIAL CONTROL											
1.1.0	PIPES (MILL MADE)	1. PHY., CHEM. PROPS, DIMENSIONS, SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE), LEAK TIGHTNESS	MA	PHY, CHEM. TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART HYDRO TEST	TECH. SPEC., IS:4711	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MFR.TC/ LAB REPORT	3	-	2,1	SAMPLE IDENTIFICATION BY BHEL
1.2.0	FITTINGS	1. PHY, CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/HEAT	-DO-	-DO-	-DO-	3/2	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3/2	-	2,1	
1.3.0	PLATE FOR FLANGES, FABRICATED PIPING AND FORGINGS FOR FLANGES	1. PHY. CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/CAST	-DO-	-DO-	-DO-	3	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3	-	2,1	
2.0.0	IN PROCESS CONTROL											
2.1.0	PIPES, FITTINGS, FLANGES - MACHINING, BENDING	1. DIMNS. INCLUDING THINNING, OVALITY, FINISH, WRINKLES ETC.	MA	MEASUREMENTS, VISUAL EXAM.	100%	MANUFAC- TURING DRG.	MANUFAC- TURING DRG.	I. R	3/2	-	2,1	
2.2.0	WELDING PROCEDURE SPECIFICATION	1. CORRECTNESS	MA	EXAM	100%	IS:7307/ ASME - IX	IS:7307/ ASME - IX	FORMAT OF IS:7307/ ASME - IX	3/2	-	2,1	
2.3.0	PROCEDURE QUALIFICATION AND WELDER'S QUALIFICATION	1. WELD SOUNDNESS	MA	PHY. TESTS	ASME IX IS:7310 IS:7307	IS:7310/ ASME - IX	IS:7310/ ASME - IX	FORMAT OF IS:7310/ ASME - IX	3/2	2,1	-	
2.4.0	WELD FIT-UPS	1. DIMNS.,	MA	MEASUREMENT,	100 %	W.P.S,	W.P.S,	I.R	3/2	2	1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		
			BIDDER'S/ VENDOR'S COMPANY SEAL

		QUALITY PLAN SHEET 2 OF 3				CUSTOMER :		PROJECT :			SPEC. NO	
						BIDDER/VENDOR		QP NO.PE-QP-999-100-MO41		REV.00 DT. 31.03.99	VOLUME: II-B	
						SYSTEM:		ITEM: PIPES & FITTINGS			SECTION D	
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
2.5.0	WELDS A) BUTT WELDS WITH JOINT EFFICIENCY OF 1.0 & 0.9 I) ROOT RUN ii) FINAL RUN	ALIGNMENT, ORIENTATION I) WELD DEFECTS I) WELD DEFECTS	MA MA	VISUAL PENETRANT TEST -DO- RADIOGRAPHY TEST	100% 100% FOR JT. EFF. 1.0 & 10% FOR JT. EFF. 0.9	APPD. DRGS. IS:3658/ ASTM E 165 -DO- ASME B 31.1	APPD. DRGS. ASME VIII DIV.I ASME B 31.1 -DO- ASME B 31.1	INSPN. REPORT -DO-	3/2 3/2	2 2/1	1 -	FILMS TO BE SHOWN TO BHEL FOR APPROVAL
	B) OTHER BUTT WELDS WITH JOINT EFF. LESS THAN 0.9	1. WELD DEFECTS (FOR ROOT RUN & FINAL RUN)	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME B 31.1	INSPN. REPORT	3/2	2,1	-	
3.0.0	COMPLETE PIPE WORK & PIPES INCLUDING GALVANIZED/ RUBBER LINED PIPING (BEFORE GALVANIZING/ RUBBER LINING)	1. WORKMANSHIP AND FINISH, DIMNS., ORIENTATION, LEAK TIGHTNESS	CR	MEAS, VISUAL, HYDRO TEST AT 1.5 X DESIGN PRESS.	100%	APPD. DRGS.	APPD. DRGS., NO LEAKAGE	I.R.	3/2	2,1	-	
3.1.0	COMPLETE PIPE WORK (DULY GALVANIZED AS APPLICABLE)	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%	IS:4736/ IS 2629 & TECH. SPECN.	IS:4736/ IS 2629 & TECH. SPECN.	INSPN. REPORT	3/2	2,1	-	
		2. UNIFORMITY OF COATING	MA	DIP TEST	SAMPLING AS PER IS	IS 2633 & TECH. SPECN.	IS 2633 & TECH. SPECN.	-DO-	3/2	2,1	-	

BHEL		PARTICULARS	BIDDER/VENDOR	BIDDER'S/ VENDOR'S COMPANY SEAL
		NAME		
		SIGNATURE		
		DATE		

		QUALITY PLAN SHEET 3 OF 3				CUSTOMER :		PROJECT :			SPEC. NO			
						BIDDER/VENDOR		QP NO.PE-QP-999-100-MO41		REV.00 DT. 31.03.99		VOLUME: II-B		
						SYSTEM:		ITEM: PIPES & FITTINGS			SECTION D			
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V			REMARKS		
3.2.0	COMPLETE PIPE WORK (RUBBER LINING AS APPLICABLE)	3. MASS OF ZINC COATING	MA	STRIP TEST	-DO-	IS 4736/ IS 6745 & TECH. SPECN.	IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-			
		5. ADHESION	MA	ADHESION TEST	-DO-	IS-2629/ IS 4736 & TECH. SPECN.	IS-2629/ IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-			
----- AS PER QUALITY PLAN FOR RUBBER LINING-----														
4.0.0	PAINING AND PACKING	1. SURFACE PREPARATION, DFT, NO. OF COATS, SOUNDNESS OF PACKING, MARKING ETC.	MA	VISUAL EXAM, MEASUREMENT	100%	APPD. PROCEDURE	APPD. PROCEDURE	I.R, MFRS CHECK LIST	3/2	-	2,1			

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

SR.		COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1		2	3	4	5	6	7	8	9	D*	M	B	C	10
 BHARAT HEAVY ELECTRICALS LIMITED MANUFACTURERS NAME & ADD ITEM : Sump pumps/Submersible Pump Q P NO: PE-QP-999-100-N005 REV-02 DATE: 14.06.16 PAGE 1 OF 2 PROJECT : END CUSTOMER: CONTRACT No.: MAIN SUPPLIER: BHEL, Noida														
1.0 Raw Material and Bought out Control														
1.1a	Pump Casing	Physical Properties - Tensile Strength & Hardness / Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V		
1.1b	Impeller	Physical Properties - Tensile Strength, Yield Strength & Elongation Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V		
1.2	Heat treatment of Stainless Steel Castings	Heat Cycle	MA	Verification of HT chart	All Batches	Appd. C S Drg.	Approved drawing/Data sheet	Corelated HT charts	√	P	V	V		
1.3	Bars / forgings for pump and motor shafts	Physical/Chemical Properties	CR	Physical / Chemical Analysis	1 / Bar	Appd. C S Drg.	Approved drawing/Data sheet	Mill TC or lab report	√	P	V	V		
		Dimensions	MA	Measurment	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V		
		Internal defects for 40 mm and above diameter	CR	UT	100%	ASTM A-388	Refer Note 1	IR	√	P	V	V		
1.4	Cable Type: PVC insulated, multicore, copper conductor	Routine TC and acceptance TC as per IS 694/Is1554, Length and size	MA	Measurement	100%	Approved Datasheet / IS 694/IS1554	Approved Datasheet / IS 694/IS1555	IR & TC	√	P	V	V		Compliance cert. To be submitted by Vendor
1.5	Bearings	Make, Bearing No., Surface finish	MA	Visual Examination	100%	Manufacturers Std	Manufacturers Std	IR		P	V			
2.0 Inprocess Control														
2.1	All Components	Visual Defects	MA	Visual	100%	Manufacturers Drawing	No harmful defects	Log book / IR		P	V	V		
		Dimensions	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V		
2.2	Pump discharge casing	Leak tightness	CR	Hydro test (Duration 30 minutes min.)	100%	Refer Remark.	No leakage	IR	√	P	W	V		Test Pr.2 x duty pts. Pr. OR 1.5 x shut off whichever is higher
	Motor Housing	Leak tightness	CR	Air test (Duration 30 Minutes min)	100%	Air test at 0.5 kg/cm2 (guage pressure)	No leakage	IR	√	P	V	V		
2.3	Casing & Impeller (machined surfaces)	Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V		On machined surface only
2.4	Impeller	Static & Dynamic residual unbalance	CR	Static, Dynamic balancing	100%	ISO : 1940	ISO 1940 Gr. 6.3	IR	√	P	V	V		
2.5	Pump Motor Shaft	Internal Defects	CR	DPT	100%	ASTME:388	ASTME:388, Refer note 1	IR	√	P	V	V		On machined surface only
		Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V		On machined surface only
3.0 Sub-Assembly, Assembly Control														
3.1	Pump, Motor, Rotor	Eccentricity	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V		
3.2	Pump and Motor assembly	Completeness, correctness	MA	Visual Examination	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V		
MANUFACTURER/ SUBCONTRACTOR SIGNATURE LEGEND: RECORDS IDENTIFIED WITH "TRK" () SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION ** M: MANUFACTURER/SUB CONTRACTOR B: BHEL, C: CUSTOMER (END USER) P : PERFORM W: WITNESS V : VERIFICATION AS APPROPRIATE BHEL DOC No.:PE : V8 - XXX - 100-N005 NAME AND SIGN OF APPROVING AUTHORITY AND SEAL														
ENGG DIV / QA & I														

SR. NO		COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1		2	3	4	5	6	7	8	9	D*	10		
4.0		Final Inspection, Test, Packing, Despatch Control											
4.1	Pump set (Pump+ Motor)	Q Vs Head, Q Vs Power Q Vs Efficiency	CR	Performance test	100%	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS, Test procedure	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS	Performance test record, Plotted Curves	Ö	P	W	V	
4.2	Routine Test on motor	HV, IR, Locked Rotor, No Load, Make type, Rating	CR	Electrical tests	100%	IS 325	Approved Data Sheet	IR	Ö	P	V	V	Winding resistance ** Degree of protection shall be IP 68, HV at 2.5 KV AC for 1 Minute.
4.3	Strip down after Performance test	Undue wer, tear and breakages	CR	Visual examination of Casing & Impeller after stripping	100%	Undue wer, tear and breakages	No undue wear, tear and breakages	IR	Ö	P	W	V	Witnessing one no. of each type
4.4	Complete Pump	Completeness, Correctness, Workmanship and finish, overall dimensions	MA	Visual examination	100%	Approved G.A. drawing	Approved G.A. drawing	IR	Ö	P	V	V	Compliance report for accessories will be submitted.
4.5	Completion of all stages	Completion	MA	Verification of IR's TC's	100%	Approved QP	Approved QP	IR	Ö	P	V	V	
4.6	Painting	Surface Preparation		Visual examination	100%	Approved data sheet/Manufacturer standard		IR		P	V	V	Compliance report by Manufacturer
		Adhesion, Uniformity and thickness		Visual Measurement	100%	As per painting schedule/Manufacturer standard		IR		P	W	V	Compliance report by Manufacturer
4.7	Wooden Packing	Soundness, Aesthetic		Visual	100%	As per packing procedure		IR		P			Compliance report by Manufacturer
Note :													
1. For accessories and bought out items, Manufacturer will submit Compliance for review.													
2. For UT test on shaft, defect echo < 20 % full screen height when back wall echo set @ 100 % screen height. Reduction in back wall echo to be <20%. Defect height > 20 % of FSH is not acceptable, also loss in backwall echo>20 % not acceptable.													
3. IP 68 protection certificate for test conducted on similar motor shall be submitted for review													
4. Compliance for provision of thermic switch for over heating protection of winding, reverse rotation protection device shall be submitted by Manufacturer													
5. For control panel separate QAP is applicable.													
6. Before sending the documents for approval, supplier to ensure that "Reference documents" & "acceptance Norms" does contain data required for the Characteristic to be checked" as indicated in QP.													
				LEGEND: RECORDS IDENTIFIED WITH "TICK" () SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION		BHEL DOC No.:PE : V8 - XXX - 100-N005							
		BHEL		** M: MANUFACTURER/SUB CONTRACTOR		NAME AND SIGN OF APPROVING AUTHORITY AND SEAL							
MANUFACTURER/		CONTRACTOR		B: BHEL, C:CUSTOMER (END USER)									
SUBCONTRACTOR				P : PERFORM W: WITNESS V : VERIFICATION AS APPROPRIATE									
SIGNATURE													
												ENGG DIV / QA & I	

		MANUFACTURERS NAME & ADDRESS		STANDARD QUALITY PLAN				PROJECT PACKAGE PROJECT No CONTRACTOR					
		(AS PER BHEL APPROVED VENDOR LIST)		ITEM:		QP NO							
				Chain Pulley Block With Trolley		REV 0 DATE 20.02.2001 PAGE 1 of 3							
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	M	C	N	REMARKS
1	2	3	4	5	6	7	8	9		**	10		11
RAW MATERIAL & B/OUT ITEMS:													
1.1	HOOKS	DIMENSIONS CHEMICAL COMPOSITION IDENTIFICATION & CORELATION WITH TC	MA MI MA	MEASUREMENT LAB ANALYSER VERIFICATION		IS 8610 GR M/P DRAWING	IS 8610 GR M/P DRAWING & SPECIFICATION	T.C.		P	-	-	
1.2	LOAD CHAIN	DIMENSIONS BREAKING STRENGTH		MEASUREMENT TENSILE TEST	100%	IS 6216	IS 6216	MFR'S TC		P	-	-	
1.3	RAW MATL FOR GEAR/RATCHET PAWL/RATCHET WHEEL	CHEMICAL COMPOSITION	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			
1.4	LOAD CHAIN WHEELS	TENSILE STRENGTH	MA	TENSILE TEST	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			
		LEGND											
				* RECORDS IDENTIFIED WITH 'TICK'() SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION ** M: MANUFACTURER/SUBCONTRACTOR C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"				REVIEWED BY					
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR											
SIGNATURE								NAME & SIGN OF APPROVING AUTHORITY &SEAL					

		MANUFACTURERS NAME & ADDRESS		STANDARD QUALITY PLAN				PROJECT PACKAGE					
		(AS PER BHEL APPROVED VENDOR LIST)		ITEM: Chain Pulley Block With Trolley		QP NO REV 0 DATE 20.02.2001 PAGE 2 of 3		PROJECT No CONTRACTOR					
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9		M	C	N	11
										**	10		
2	PROCESS												
2.1	HOOKS	PROOF LOAD	MA	LOAD TEST	100%	IS 8610	IS 8610	IR		P	W		
		DPT AFTER PROOF LOAD	MA		100%	ASTM 709	ASTM 709	IR		P	W		
2.2	RACHET PAWL/RACHET WHEEL	HARDNESS	MA	HARDNESS TESTER	100%	IS :1832	IS : 3832	IR		P	W		
		SURFACE CRACKES	MA	DPT	100%	ASTME				P	W		
2.3	LOAD CHAINS	PROOF - LOAD	MA	LOAD TEST	100%	IS : 6216	IS:6216	MFR'S		P			
3	FINAL INSPECTION												
3.1	COMPLETE ASSEMBLY	PROOF LOAD TEST	CR	LOAD TEST	100%	IS: 3832	IS: 3832	IR		P	W	W	
		OPERATIONAL EFFORT	MA	LOAD TEST	RANDOM	IS: 3832	IS: 3832	IR		P	W	W	
		HEIGHT OF LIFT	MA	MEASUREMENT	100%	IS: 3832	IS: 3832	IR		P	W	W	
		SWIVELLING OF HOOK	MA	VISUAL	100%	IS: 3832	IS: 3832	IR		P	W	W	
		LEGND											
				* RECORDS IDENTIFIED WITH 'TICK'() SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION									
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR		** M: MANUFACTURER/SUBCONTRACTOR C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"				REVIEWED BY					
SIGNATURE										NAME & SIGN OF APPROVING AUTHORITY &SEAL			

		MANUFACTURERS NAME & ADDRESS		STANDARD QUALITY PLAN				PROJECT					
		(AS PER BHEL APPROVED VENDOR LIST)		ITEM:		QP NO		PACKAGE		PROJECT No			
				Chain Pulley Block With Trolley		REV 0				CONTRACTOR			
						DATE 20.02.2001							
						PAGE 3 of 3							
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9		M	C	N	11
** 10													
3.2	PAINTING	CLEANED SHADE OF PAINT GOLDEN YELLOW	MA MA	VISUAL VISUAL	AT RANDOM AT RANDOM	SPEC. SPEC.	PE PE	IR IR		P P	- W	- W	
3.3	NAME PLATE	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	
3.4	PACKING	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	
				LEGND * RECORDS IDENTIFIED WITH 'TICK' () SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION ** M: MANUFACTURER/SUBCONTRACTOR									
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR		C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" NTPC SHALL IDENTIFY IN				REVIEWED BY		NAME & SIGN OF APPROVING AUTHORITY &SEAL			
SIGNATURE				COLUMN"N"									

STANDARD QUALITY PLAN

PROJECT
VENDORSYSTEM
ITEM BUTTERFLY VALVES

S N	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT. EQUIP- RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE-NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10	11	12	
10	RAW MATERIAL BOUGHT-OUT CONTROL											
11	1. SHAFT SEAT RING	1. CHEM. COMPOSITION & PHYS. PROPS 2. INTERNAL DEFECTS OF SHAFT DIA 150MM	MA CR	CHEM. & PHYS TESTS UT	ONE HEAT BATCH 100%	TECH. SPEC. APPD. DRG. ASTM A388 B XE 100%	TECH. SPEC. (APPD. DRG.	LAB. REPORT INSPN. REPORT INSPN. REPORT	3/2 3/2	2.1 2.1	CORRELATION NOT REQUIRED FOR GREY CI. FOR OTHER POURING WITNESS BY BHEL. MATERIAL IDENTIFICATION BY SHAFTS BY BHEL. NOTE: COMPLIANCE TO FL- MS & CI CORRELATION & IDENTIFICATION FOR SS	
12	DISC & SHAFT SEAL	3. CASTING DEFECTS/ FORGING DEFECT 1. VISUAL INSPECTION 2. DIMENSIONS 3. HARDNESS 4. OZONE RESISTANCE 5. AGEING TEST	MA MA MA MA MA	1. VISUAL 2. MPI VISUAL MEAS MEAS TESTING	100% 100% 100% 1/BATCH 100%	MSSSP65 TECH. SPEC. APPD. DATA SHEET TECH. SPEC. -DO- -DO- -DO- ASTM D 1149 -DO- IS 3400	MSSSP55 TECH. SPEC. (APPD. DATA SHEET TECH. SPEC. -DO- -DO- -DO- RELV. STD. -DO-	QC LOG BOOK -DO- TEST CERT. -DO- -DO-	3/2 3/2 3/2 3/2 3/2	2.1 2.1 2.1 2.1 2.1	COMPLIANCE TO	
13	COUNTER-FLANGES	1. CHEM. PHYS. PROPERTIES	MA	CHEM. PHYS. TEST	1 HEAT	APPD. DRG. / DATA SHEET	APPD. DRG. / DATA SHEET	LAB. REPORT, INSPN. REPORT	3/2	2.1	COMPLIANCE TO FOR MATERIAL IDENTIFICATION BY BHEL	
O.P. NO.		PEM/MSE/SQP/03	PREPARED BY		PEM J	REVIEWED BY	CQS & PEM	APPROVED BY	PEM	ACCEPTED BY		
REV. NO./DATE		00/8-10-97	NAME							VENDOR		
PAGE NO.		1 OF 7	SIGNATURE							NAME		
			DATE							SIGN.		
										DATE		

BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT												
PROJECT: VENDOR				SYSTEM: ITEM BUTTERFLY VALVES								
S. NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT. EGO. RY	TYPE / METHOD OF CHECK	EXTEN. OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10	11	12	
		2. DIMENSION	MA	MEASURE- MENT	100%	-DO-	-DO-	INSPN. REPORT	3/2	2	1	
		3. INTERNAL DEFECTS FOR THICKNESS 50MM AND ABOVE	CR	UT	100%	ASTM A435	ASTM A435	INSPN. REPORT	3/2	2	1	
		4. HEAT TREATMENT		SRM 1 CHART	100%	STANDARD PRACTICE	STANDARD PRACTICE	CORRELATED SRM 1 CHART	3/2			
4	FASTENERS (APPROX. MAKE)	1. VERIFICATION OF MAKE GRADE	MA	VISUAL	100%	TECH. SPEC. DATA SHEET	TECH. SPEC. DATA SHEET	INSPN. REPORT	3/2	2	1	
5	OPERATORS (GEAR BOX GEAR)	COMPOSITION	MA	CHEM. ANALYSIS	ONE/BATCH	AS PER MATERIAL SPEC	AS PER MATERIAL SPEC	T.C.C.	3	3	2/1	
5.1	GEAR WORM SHAFT	HARDNESS	MA	MEAS.	SAMPLING	AS PER APPD. DRG. MATL. SPEC	AS PER APPD. DRG. MATL. SPEC	T.C.C.	3	3	2/1	
		DIMENSION	MA	-DO-	-DO-	-DO-	-DO-	REPORT	3	3	2/1	UT ON GEAR BLANKS
		NOT	MA	UT/MP	100%	-DO-	-DO-	T.C.C.	3	3/2	2/1	UT ON SHAFTS & SCRM DIA
5.2	TORQUE TEST OF GEAR BOX AT 2x RATED TORQUE	TORQUE TRANSMITTING	MA	TESTING	ONE/TIME	AWWA C504 STD 67	AWWA C504 STD 67	T.C.C. CHP	3	3/2	2/1	UT ON SHAFTS & SCRM DIA MPI OR LPI ON GEAR & SHAFT AFTER MACHINING NO DAMAGE TO THE FACE OF GEAR
5.3	ELECTRICAL ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH. ELEC. TESTS	100%	TECH. SPEC. / APPD. DRG. DATA SHEET / IS 9334	APPD. DRG. DATA SHEET / IS 9334	INSPN. REPORT	3	2	1	BHEL TO WITNESS - PER TYPE IF QTY IS MORE THAN 10/TYPE
Q.P. NO.	PEM/MSE/SOP/03	PREPARED BY:		REVIEWED BY:		APPROVED BY:		ACCEPTED BY:				
REV. NO./DATE	00/B-10-97	PEN		COS & PEM		PEM		VENDOR				
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		SIGNATURE						SIGN.				
		DATE						DATE				

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM BUTTERFLY VALVES

NO	EVENT / OPERATION	CHARACTERISTICS CHECKED	CAT. EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS								
									P	W										
1	2	3	4	5	6	7	8	9	10	11	12	13								
1	HYD. WHEEL	2. TRAVEL / STROKE	MA	WATER DUST TEST	1/TYPER	-DO-	-DO-	3rd PARTY TEST CERT.	3	2.1										
		3. TRAVEL TIME	MA																	
		4. OPERATION OF LIMIT SWITCH	MA																	
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA																	
		6. OPERATION TEST WITH POWER SUPPLY VARIATION, ENERGISE TO OPEN/CLOSE, CURRENT DRAWN	MA																	
		7. IR, HV, IR	MA																	
		8. DEGREE OF PROTECTION	MA																	
		1. CHEM. & PHYS. PROPS	MA										CHEM. PHYS. TESTS	1/HEAT BATCH	APPD. DRG. / DATA SHEET	APPD. DRG. / DATA SHEET	TEST CERT.	3/2	2.1	
		2. HARDNESS	MA										MEAS	100%	-DO-	-DO-	-DO-	3/2	2.1	
		3. DIMENSIONS	MA										MEAS	100%	MFG. DRG.	MFG. DRG.	LOG BOOK	3/2		
4. LEAK TIGHTNESS	MA	HYDRO TEST	100%	APPD. DATA SHEET	NO LEAKAGE	INSPN. REPORT	3/2	2.1												
3. P. 1. 1.	1. CHEM. PHYS. PROPS.	MA	CHEM. PHYS. TESTS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TEST CERT.	3/2	2	1.1										
	2. DIMENSION	MA	MEASUREMENT	100%	MFG. DRG.	MFG. DRG.	LOG SHEET	3/2												
Q.P. NO	PEM/MSE/SQP/03	PREPARED BY		REVIEWED BY		APPROVED BY		ACCEPTED BY												
REV. NO DATE	00/8-10-97	PEM		CQS & PEM		PEM		VENDOR												
PAGE NO	3 OF 7	NAME						NAME												
		SIGNATURE						SIGN												
		DATE						DATE												

BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT												
STANDARD QUALITY PLAN												
PROJECT VENDOR		SYSTEM: ITEM: BUTTERFLY VALVES										
S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT- EGO- RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMA OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10	11	12	
2.0	IN-PROCESS CONTROL	1. CHEM. PHYS. PROPS	MA	CHEM. PHYS. TESTS	100%	MATL. SPEC. / APPD. ORG.	MATL. SPEC. / APPD. ORG.	LOG BOOK	3/2	2	1	
		2. DIMENSIONS	MA	MEAS.	100%	MFG. ORG.	MFG. ORG.	LOG BOOK	3/2	2	1	
		3. FINISHNESS	MA	MEAS.	100%	-DO-	-DO-	TEST CERT.	3/2	2	1	
2.1	BODY & DISC	1. SURFACE DEFECTS	MA	PT	100%	ASTME-165	NO DEFECTS	INSPN. REPORT	3/2	2	1	
		2. DIMENSIONS	MA	MEAS.	100%	MFG. ORG.	APPD. ORG.	LOG BOOK	3/2			
		3. LEAK TIGHTNESS OF DISC	MA	HYDRO TEST	100%	TECH. SPEC. / APPD. ORG. / DATA SHEET	NO LEAKAGE	INSPN. REPORT	3/2		2.1	
2.2	SHAFT	1. DIMENSIONS	MA	MEAS.	100%	MFG. ORG.	APPD. ORG.	LOG BOOK	3/2			
		2. SURFACE DEFECTS	MA	PT	100%	ASTME-165	NO SURFACE DEFECTS	INSPN. REPORT	3/2		2.1	
		3. FINISHNESS	MA	MEAS.	100%	MFG. ORG.	APPD. ORG.	LOG BOOK	3/2			
2.3	SEAT RING	1. DIMENSIONS	MA	MEAS.	100%	MFG. ORG.	APPD. ORG.	LOG BOOK	3/2			
		2. TENSILE STRENGTH IN CASE OF RUBBER SEAT	MA	PEEL STRENGTH	ONE/BATCH	ASTM D 429	ASTM D 429	TEST CERT.	3/2		2.1	
		3. FINISHNESS	MA	MEAS.	100%	MFG. ORG.	MFG. ORG.	-DO-	3/2	2	1	

Q.P. NO.	PEM/MSE/SOP/03	PREPARED BY		REVIEWED BY	APPROVED BY	ACCEPTED BY	
		PEM		CQS & PEM	PEM	VENDOR	
		NAME				NAME	
		SIGNATURE				SIGNATURE	
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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM:
ITEM: BUTTERFLY VALVES

S NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CAT- EGO- RY	TYPE & METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
	2	3	4	5	6	7	8	9	10			11
2.4	WELDED FLANGES/QUARTER FLANGES	1 SURFACE DEFECTS	MA	RT	100%	ASTME 165	NO SURFACE DEFECTS	DO	3/2	2	1	FOR FABRICATED FLANGES ONLY FILMS TO BE SOWN TO SHEL
			MA	PHYS TESTS	100%	ASME IX	ASME IX	FORMATS OF ASME IX	3/2	2	1	
		1 FIT UP	MA	MEAS. TEMPLATE, VISUAL	100%	MFG DRG	MFG DRG	LOG BOOK	3/2		2.1	
		2 INTERNAL DEFECTS OF WELDMENTS	CR	RT/AUT	100%	ASME VIII DIV I	ASME VIII DIV I	RADIO GRAPH REPORT FILMS	3		2.1	
2.4.1	WELDING PROCEDURE SPECIFICATION	CORRECTNESS	MA	EXAM	100%	ASME SEC IX	ASME SEC IX	QW482 OF ASME SEC IX	3/2		2.1	WELDING PROCEDURE APPROVED BY EHEL AS WELL AS 3RD PARTY (LY DQS, BVOI OR EQ.)
2.4.2	WELDING PROCEDURE QUALIFICATION	WELD SOUNDNESS	MA	VISUAL, PHYS. TESTS RT (AS APPLICABLE)	100%	ASME SEC IX	ASME SEC IX	QW483 OF ASME IVIS	3/2	2.1		
2.4.3	WELDER PERFORMANCE QUALIFICATION	WELD SOUNDNESS	MA	DO	100%	ASME SEC IX	ASME SEC IX	QW484 OF ASME	3/2	2.1		
Q.P. NO.	PEM/MSE/SQP/03	PREPARED BY		REVIEWED BY		APPROVED BY		ACCEPTED BY				
		PEM		COS & PEM		PEM		VENDOR				
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BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT												
PROJECT VENDOR				SYSTEM : BUTTERFLY VALVES								
STANDARD QUALITY PLAN												
S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10	11	12	
2.4.4	WELD FIT-UPS	1. DIMENSIONAL ALIGNMENT	MA	MEAS. VISUAL EXAM	100%	WPS, MFG. DRAWING	WPS, MFG. DRAWING	IR LOG BOOK	3/2			WITNESSING OF U T
2.4.5	ROOT RUNS	1 SURFACE DEFECTS	MA	PENETRANT TEST	100%	ASTME 165	NO SURFACE DEFECT	-DO-	3/2		2	
2.4.5	WELDMENTS	1 SURFACE DEFECTS	MA	-DO-	100%	ASTME 165	ASME-VIII, DIV. I	INSPN REPORT	3/2	2,1		
2.4.7	BUTT WELDS	INTERNAL DEFECT	MA	UT/RT	100%			IR	3/2		2,1	
2.4.8	SPR WELDING	SPR		SPR	100%	ASME SEC. V	ASME SEC. VIII, DIV. I	IR	3/2		2,1	
2.5	FINAL ASSEMBLY											
2.6	VERIFICATION OF ALL PREVIOUS TEST AND DOCUMENTS	VERIFICATION OF RECORDS	MA	-DO-	100%	TECH. SPEC.	TECH. SPEC		2		1	
2.7	TESTS (HYDRAULIC)	1 BODY TEST 2 DISC STRENGTH 3 SEAT LEAKAGE 4 PERFORMANCE TEST	MA MA MA MA	HYDRO TEST HYDRO TEST -DO- PERFORMANCE	100% 1/TYPE 100% 3 TIMES	TECH. SPEC / REL STD -DO- -DO- -DO-	TECH / SPEC / REL STD -DO- -DO- -DO-	TEST CERT -DO- -DO- -DO-	3/2 3/2 3/2 3/2	2,1 2,1 2,1 2,1		
O.P NO		PEM/MSE/SQF/03		PREPARED BY PEM		REVIEWED BY CQS & PEM		APPROVED BY PEM		ACCEPTED BY VENDOR		
REV N D DATE		00/8-10-97		NAME						NAME		
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				DATE		211				DATE		

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM BUTTERFLY VALVES

1	2	3	4	5	6	7	8	9	10 AGENCY			11
									P	W	V	
		5. TESTING OF ACCESSORIES	MA	TESTING	100%	TECH SPEC /REL STD	TECH SPEC /REL STD	TC	32	2		NOTE: IF CYCLE LIFE TEST ALREADY CONDUCTED ON SIMILAR SIZE RANGE & VALVE REPORT SHALL BE SUBMITTED
		6. PROOF OF DESIGN TEST	MA	TESTING	100%	DO.	DO.	TC	32	2		
	SHIPPING RELEASE	1. OVERALL DIMENSIONAL	MA	MEASUREMENT	100%	APPD DRG	APPD DRG		32	2		
	FINAL INSPECTION	2. DOCUMENTATION VIEW	MA	REVIEW	100%	TECH SPEC APPD DRG	TECH SPEC APPD DRG		32	2		
		3. CLEANLINESS	MA	VISUAL	100%	DO.	DO.		32	2		
		4. NAME PLATE DETAILS	MA	VISUAL	100%	DO.	DO.		32	2		
		5. STAMPING	MA	STAMPING	100%	DO.	DO.		32	2		
	PAINING	1. SURFACE PREP	MI	VISUAL MEAS.	100%	TECH SPEC	TECH SPEC	INSPN REPORT	32	2	1	
		2. UNIFORMITY & THICKNESS	MI	DO.	100%	DO.	DO.	DO.	32	2	1	
O.P. NO.	PEM/MSE/SQP/03	PREPARED BY		REVIEWED BY		APPROVED BY		ACCEPTED BY				
REV NO/DATE	00/8-10-97	NAME		NAME		NAME		VENDOR				
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		DATE		DATE		DATE		DATE				

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS STANDARD TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: II
		SUB-SECTION: IIB
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION - IIB

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS 1 X 660MW BHUSAWAL TPS STANDARD TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: II
		SUB-SECTION: IIC
		REV. NO. 0 DATE 02.11.2018
		SHEET 1 OF 1

SUB-SECTION - IIC

STANDARD TECHNICAL SPECIFICATION (C &I)

	TITLE: TECHNICAL SPECIFICATION NATRURAL DRAFT COOLING TOWERS 1X660MW MAHAGENCO BHUSAWAL TPS STANDARD TECHNICAL REQUIREMENTS	SPEC. NO.: PE-TS-415-165-N002
		SECTION: III
		SUB-SECTION:
		REV. NO. 0 DATE 06.11.2018
		SHEET 1 OF 1

SECTION III

DOCUMENTS TO BE SUBMITTED BY BIDDER

	TITLE: TECHNICAL SPECIFICATION NATURAL DRAFT COOLING TOWERS COMPLIANCE CERTIFICATE 1X660MW MAHAGENCO BHUSAWAL TPS	SPEC. NO.: PE-TS-415-165-N002	
		SECTION: III	
		REV. NO. 0	DATE 06.11.2018
		SHEET 1	OF 1

COMPLIANCE CERTIFICATE

The bidder shall give his acceptance to the following by signing and stamping this compliance certificate and furnish the same with his offer.

- a) The scope of supply, technical details, construction features, design parameters etc. are as per technical specification and there are no exclusions with regard to the same.
- b) There are no deviations w.r.t. specification other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations.'
- c) We will submit QPs in the event of order based on the guidelines given in the specification & those enclosed therein. QPs will be subject to BHEL/CUSTOMER approval & customer hold points for inspection/testing will be marked in the QPs at the contract stage. BHEL/CUSTOMER will witness inspection/testing as per details in QPs apart from review of various test certificates/ Inspection records etc.
- d) All drawings, data sheets, calculations etc., if any submitted along with the offer are for reference and the same will be subject to BHEL/ CUSTOMER approval in the event of order.
- e) The offered materials will be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same will be suitable for intended duty and subject to approval in the event of order.
- f) We will supply commissioning spares on 'As Required Basis' & prices for same are included in the base price. Prices for special tools & tackles, if any, are also included in the base price.
- g) All sub vendors are subject to BHEL/ CUSTOMER approval in the event of order.
- h) The Performance guarantees stand valid until at least eighteen (18) months after full load commissioning of CT or as per commercial terms and conditions, whichever is later.
- i) Deleted
- j) We will carry out hydrostatic testing of piping as per specifications, i.e. at 1.5 times the design pressure.

Bidder's Authorized Signatory

Company Seal



TITLE:

**TECHNICAL SPECIFICATION
COOLING TOWERS
BHUSAWAL TPS, 1X660 MW
GUARANTEE SCHEDULE**

SPEC. NO.: **PE-TS-415-165-N002**VOLUME: **III**

SECTION:

REV. NO. **0** DATE 06.11.18SHEET **1** OF **1**

1. Guaranteed Cold water temperature at design capacity 32 Deg. C
& parameters

Authorized Signatory

Company Seal

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

FORM NO PEM 6036-1

	TITLE * SCHEDULE OF DEVIATIONS () From Conditions of Contract (Volume – 1) () From General Technical Conditions (Volume – II A) () From Technical Specifications (Volume –II B)	SPECIFICATION NO
		VOL III
		SHEET..... OF.....
We the undersigned hereby certify that the above mentioned are the only deviations.		

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	