1X370 MW YELAHANKA CCPP (KPCL)

TECHNICAL SPECIFICATION
FOR
COOLING TOWERS

VOLUME -IIB

BOOK 1 OF 2

Specification No. : PE-TS-409-165-N001

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

The tender document contains three (3) volumes. The bidder shall meet the requirements of all the three volumes.

1.1 Volume -I CONDITIONS OF CONTRACT

This consists of four parts as below:

Volume - I A : This part contains instructions to bidders for making bids to BHEL.

Volume - I B : This part contains general commercial conditions of the tender and include provision that vendor shall be responsible for the quality of item supplied by their sub-vendors.

Volume - I C : This part contains special conditions of contract.

Volume - I D : This part contains commercial conditions for erection and commissioning site work, as applicable.

1.2 Volume - TECHNICAL SPECIFICATIONS

Technical requirements are stipulated in Volume II which comprises of:

Volume - II A : General Technical Conditions

Volume - II B : Technical specification including drawings, if any

1.2.1 Volume - II B:

This volume is sub-divided into following sections:

Section - A : This section outlines the scope of enquiry.

Section - B : This section provides “Project Information”

Section - C : This section indicates technical requirements specific to the contract, not covered in Section-D.

Section - D : This section comprises of technical specifications of equipments complete with data sheet A, B & C.
Data sheet-A specifies data and other requirements pertaining to the equipment.
Data sheet - B specifies data to be filled by the bidder (Data Sheet B is contained in Volume - III)

Data sheet - C indicates data documents to be furnished after the award of contract as per agreed schedule by the vendor (as applicable).

1.2.2 Volume - III TECHNICAL SCHEDULES

This volume contains technical schedules and Data Sheets – B (to be submitted at contract stage), which are to be duly filled by the bidder and the same shall be furnished with the technical bid.

2.0 The requirements mentioned in Section C/Data Sheets-A of Section-D shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section -D.

COOLING TOWER TECHNICAL SPECIFICATION VOL IIB COMPRISES OF 2 BOOKS:

CONTENTS

SECTION - A

SCOPE OF ENQUIRY

1.00.00 SCOPE

1.01.00 This enquiry covers the complete cooling towers including design, 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, erection, site painting, commissioning, testing of Mechanical induced draft cooling tower (IDCT) including electrical, C&I, civil & structural works (including piling if any), as specified & as necessary for completeness in all respects and for efficient & trouble free operation for **370 MW YELAHANKA CCPP (KPCL).**

The Reinforcement Steel and Structural Steel for cooling tower are excluded from Bidder's scope and shall be free issue as per NIT. However, Cement shall be in scope of bidder.

For Bid evaluation of Cooling Towers, Bidder's total price shall be determined after adding cost of Steel, as per rates specified in elsewhere, in Bidder's total quoted price for CT.

Cost of Piling (if any) shall be included by bidder's in their quoted price.

2.00.00 GENERAL TECHNICAL INSTRUCTIONS

2.01.00 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer/Owner, who will interpret the meaning of drawing and specifications and shall be entitled to reject any component, work or material, which in his opinion is not in conformity with the duty requirements.

2.02.00 The omission of specific reference to any component/ accessory necessary for the proper performance of the equipments shall not relieve the bidder of the responsibility of providing such facilities to complete the supply/ erection / commissioning etc. of cooling tower and its drives at quoted prices.

2.03.00 BHEL's/ owner's representative shall be given access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

2.04.00 The equipments covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and shipping release issued by BHEL.

2.05.00 In case of any deviation from this technical specification (Vol. IIB) and General Technical Conditions (Vol. IIC), the same shall be indicated in the schedule of deviations. In the absence of duly filled schedules it will be assumed that the bid strictly conforms to the specification.

2.06.00 Un-priced copy of the price bid shall be furnished along with the technical bid.

SECTION – B

PROJECT INFORMATION

Site Location	:	The plant site is located at approx. 23 km from Kempegowda International Airport, Banagaluru, in begaluru district Karnataka. Plant is located at state highway doddabollarpur road (State highway 9, Karnataka). Nearest railway station Yeshwantpur railway station bengaluru is located approx 17 km from plant. Location co-ordinates are- Latitude – 13 deg. 7 min. Longitude – 77 deg. 35 min.
Grade level	:	Finished Graded Level (FGL) for main plant area shall be kept at RL (+) 901.00 m, and for Raw water reservoir area shall be kept at RL (+) 898.00 m above mean sea level.
Soil Condition and Ground Water Level	:	Type of foundation, depth, safe bearing capacity, ground water table etc., shall be as per the approved Geotechnical report.
Seismic Zone	:	The project site lies in zone II as defined in IS: 1893
Wind Speed	:	Design wind speed is 33 m/sec as per IS: 1893
Reference Level	:	All elevations shall be marked with reference to Finished Ground Floor elevation of Power House building as EL (±) 0.000m which corresponds to RL 901.50m.
Temperature	:	Annual mean of daily minimum temperature = 11.5° C Annual mean of daily maximum temperature = 37.0°C Design temperature = 28.0°C
Relative humidity	:	At 0830 hrs = 79% At 1730 hrs = 52%
Rainfall	:	Total annual raifall = 970mm Max. hourly rainfall intensity = 75mm

Yelahanka 1x350 MW CCPP Plant details

1	Plot plan in Auto cad Format	:Soft copy enclosed	
2	Topographical Details of site	:Contour map is enclosed	
	a Latitude	:13 Deg 7 Mir	
	b longitude	:77 Deg 35Mir	
	c Elevation	: 900 Mtr (Please Refer the Contour Map)	
3	Geotechnical investigation details	: Sample test Bore results Report (Scanned Copy) Enclosed	
4	Finished Grade Level	: Contour Map is Enclosed and Finished grade level can be finalized during the detailed engineering	
5	Highest Flood level	: Not applicable and can be finalized by studying the Plant Topography	
6	Foundation details of existing DG plant Structures	Hard copy of DG plant equipment layout Foundation details Drawings are available and can be collected by your representative	
7	Site conditions (Metrological)	:10 Year avg temp, Max,Min. temp , humidity data (Scanned Copy Details) Enclosed	
a	Elevation	: 900 Mtr (Please Refer the Contour Map)	
b	Annual Mean of Daily Max Temp	37.Deg.cent	
c	Annual Mean of Daily Min Temp	11.5 Deg cent	
	Highest Temp Recorded	39.Deg Cent	
	LowestTemp Recorded	9.9 Deg Cent	
d	Desigen Temperature	28.0 Deg Cent.	
e	Relative Humidity	at 830hrs 79%	
		at 1730 hrs 52%	
f	Annula total Rain Fall (Max rain fall during July to Oct)	970 mm	
g	Design Wind Speed	33M/sec (As per IS: 875)	
	Earthquake Zone	Seismic Zone II As per IS 1893	
8	GA drawing of KPTCL (220KV) substation	: Scanned copy of drawing is enclosed and detailed drawing will made available After collecting from KPTCL	
9	Current stack Height Restriction due to Aviation	Tentatively it is restricted to 45 Mtr only , Details of restriction shall be available after submitting the detailed Drawing of the stack to Dept. of Aviation	
10	Water Sample details	: Presently Secondary treated water sample details are available with us. However as we are proposing get **Tertiary treated water from M/s BWSSB** , the water Sample details as submitted for **Bidadi Project May be considered.**	

Note: As the Yelhanka Site 40 KM away from Bidadi site ,The Bidadi Site Parametrs can Be cosiderd For Desigen Purpose Except for the Change in elevation

Bidadi water analysis with COC=3 is attached

Annexure-1 to MOM dtd 20/2/2015

KARNATAKA POWER CORPORATION LIMITED

TITLE

350MW YCCP PLANT

QUALITY OF TREATED WATER

Sl. No.	Particulars	Units	Value specified by KPCL	Values Agreed by BWSSB
1	Colour	Hazen Units	<5	<5
2	Odour		Unobjectionable	Unobjectionable
3	Turbidity	NTU	0.6	0.6
4	pH value		7.2-7.3	7.2-7.3
5	BOD	ppm	1.2	<5
6	COD	ppm	4.9	<10
7	Total Suspended Solids	ppm	4.0	4.0
8	Total Dissolved Solids	ppm	774	<800
9	Alkalinity	ppm	24.7	24.7
10	Chloride as Cl	ppm	41.45	<200
11	Sulphates as SO_4	ppm	129	<60
12	Silica – dissolved as $Si O_2$	ppm	23.5	23.5
13	Silica – colloidal as $Si O_2$	ppm	3	3
14	Ca hardness – as $CaCO_3$	ppm	140	140
15	Mg hardness – as $CaCO_3$	ppm	94	94
16	Total hardness – as $CaCO_3$	ppm	234	300
17	% Sodium	ppm	12.14	12.14
18	Ammonical Nitrogen	ppm	6.57	6.57
19	Iron as Fe	ppm	0.31	0.31
20	Manganese as Mn	ppm	<0.05	<0.05
21	Total Kjeldhal Nitrogen	ppm	3.4	3.4
22	Total Residual Chlorine	ppm	<0.5	<0.5
23	Phosphate as PO_4	ppm	1.3	1.3
24	Free Ammonia	ppm	<0.1	<0.5
25	Total Phosphorus	ppm	0.56	1.0
26	Oil & Grease	ppm	<1.0	<1.0
27	Nitrate nitrogen	ppm	1.3	1.3
28	Sulphide	ppm	<0.05	<0.05
29	Flouride as F	ppm	0.39	0.39
30	Copper as Cu	ppm	<0.05	<0.05
31	Zinc as Zn	ppm	<0.05	<0.05
32	Lead as Pb	ppm	<0.02	<0.02
33	Total Chromium as Cr	ppm	<0.05	<0.05
34	Mercury as Hg	ppm	<0.001	<0.001
35	Cyanide as CN	ppm	<0.05	<0.05
36	Phenolic Compounds as C6H5OH	ppm	<0.05	<0.05
37	Nickel as Ni	ppm	<0.05	<0.05
38	Arsenic as As	ppm	<0.001	<0.001
39	Coliform Organisms/100ml	ppm	15×10^5	<1
40	Faecal Coliform Organisms/100ml	ppm	15×10^5	<1
41	MPN Count/100ml		2	<1
42	E-Coli		Present	-

* The worst TDS expected from the tertiary water is about 800 ppm. The equipment/system shall be designed for the same.

CHIEF ENGINEER (G.S.W)
Karnataka Power Corporation Ltd.

SECTION - C

SPECIFIC TECHNICAL REQUIREMENTS

SECTION C1 - Specific Technical Requirements (Mech.) including Data Sheet – A
SECTION C2 - Specific Technical Requirements (Electrical)
SECTION C3 - Specific Technical Requirements (C & I)

SECTION – C1

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL) INCLUDING DATA SHEET-A

1.00.00 INTENT OF SPECIFICATION:

1.01.00 This specification covers the design, manufacture, assembly, inspection/ testing at manufacturer's and/or his subcontractor's works, properly packed for transportation, delivery at site, unloading/ handling and storage at site, erection, site painting, testing at site, commissioning and performance testing of Mechanical Induced draft type cooling towers at site including complete Electrical, C&I ,Civil and structural works (including Piling) as specified and as necessary for completeness in all respect for efficient and trouble free operation for following project.

a) **1X370 MW YELHANKA CCPP (KPCL)** – One (1) No. Cooling Tower (IDCT)

The Reinforcement Steel & Structural steel required for complete Cooling Tower are excluded from bidder's scope and shall be free issue as per NIT. However, Cement shall be in scope of bidder.

The performance parameters and other particulars of Cooling Towers are detailed in Data Sheet-A.

2.00.00 SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:

The equipment and works to be provided under this specification shall be as detailed below and as indicated in relevant portion of enclosed documents.

The items not specifically mentioned but deemed necessary to make the cooling tower complete in all respects, as self-contained package for reliable and efficient operation shall also be deemed to have been included in the scope of the bidder.

The scope of supply/ works including civil works as complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements except for items specifically mentioned in exclusion list of works. Scope of works includes preparation of design and drawings, obtaining necessary approvals, materials, execution as per codes, specification, best engineering practices and to the satisfaction of BHEL/ Owner for all mechanical, architectural, civil structural, building electrification, etc. 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.

Bidder shall visit and apprise himself fully with existing site conditions including soil condition, rainfall data, availability of all construction materials including backfill, graded material etc. and other aspects for construction of plant, building structures etc. No extra claim whatsoever on any account shall be entertained by BHEL.

The bidder shall furnish list of items/ services not included in his scope, otherwise the complete package shall be deemed to be in bidder's scope & Purchaser's interpretation in this regard shall be final & binding on the bidder.

The brief scope of supply, services & works for cooling tower, complete with hot water distribution system, cold water basin and outlet channels, sludge pit, stair case from ground level to deck and all other equipments and accessories as mentioned herein after. It is not the intent to list all details herein; scope of supply listed is in brief.

2.01.00 Cooling Tower shall be complete with following:

2.01.01 Scope (Mechanical):

a) Fans each complete with drive shaft, lubrication system, gearbox, couplings, coupling guards, drive motor & base plate. Rain hood for drive motor & removable access walk way with gratings / other suitable arrangement for approach from stack door at tower level to fan gearbox.

b) Complete handling arrangement for fan, gearbox & motor etc. for lifting from ground level to deck level & thereafter for handling at deck level. This shall include permanently installed chain pulley blocks at end wall, trolley for movement at deck level & lifting/ handling arrangements at respective fan/ gearbox/ motor locations.

c) Incoming hot water piping including vertical run supported on cooling tower, Manual Operated Butterfly valves on hot water risers. Terminal point for hot water pipe and cold water pipe header shall be as marked in the tender drawing enclosed at **Annexure-1** to Data Sheet - A. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a pressure gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope.

d) Inlet louvers, tower fills & fill supports, drifts eliminator including all supporting structures, fastening arrangements & accessories.

e) Screens, along with guides embedded in concrete shall be provided at the outlet of cold water basin.

f) Stop log gates and guides embedded in concrete at the outlet of cold water basin.

g) Valves in sludge pit complete with extension spindle & pedestal type manual operator. The pipe spools shall be embedded in the wall through which extension spindle will be protruding.

h) Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply.

i) Two (2) Nos. (1+1) sludge pumps (Horizontal 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.

k) The basin shall be partitioned suitably to facilitate isolation and maintenance.

2.01.02 Scope (C&I):

a) Complete C&I as per specification/ details indicated in Section C3 shall be in bidder's scope.

2.01.03 Scope (Electrical):

a) Complete electrical equipments as per specification/ details indicated in Section C2 & D2 shall be in bidder's scope.

b) The scope of power & control cables & special cables shall be as per Annexure-1 of section C-2 (electrical).

c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipments & accessories.

2.01.04 Scope (Civil):

a) Complete civil works as detailed in Section - C4 & D3 including excavation, shoring, dewatering, backfilling, concrete work including casing, sidewalls, top deck, recovery stacks at tower fans outlet, foundations (including Piling if required), cold water basins, sludge pit for each basin section, staircase at both ends of cooling tower, all other staircases/ladders as required, doors and their frames, walkways, platforms, hand railing, water-proofing, finishing and all other incidental civil works including earth work for grading, removal of surplus soil to a space decided by the engineer, shuttering, steelworks for reinforcement etc.

b) Supply & application of final painting at site.

2.01.05 The following are also included in bidder's scope:

a) One set of special tools & tackles required for maintenance of equipments & accessories in the cooling towers.

b) Various drawings, datasheets, calculation, 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/ replenishment as necessary after commissioning & 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 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.

f) Recommended spares for 3 years operation – bidder to furnish list with item wised prices. These prices not to be included in the base price but to be furnished separately.

2.02.00 Exclusions

Following are excluded from the Bidder's scope:

a) Control Panels for Complete Cooling Tower, However, LCP for Sludge pumps and any other equipments (as required) shall remain in bidder's scope.

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.

b) Supply & erection of sludge discharge piping beyond the bidder's terminal point.

c) Supply & Erection of Cold-water outlet Pipe Header from cooling tower basin beyond the bidder's terminal point.

d) For Electrical, C&I and Civil works refer Sections C2/ D2, C3 & C4/ D3 respectively enclosed herein.

4.00.00 The cooling tower shall comply with standard technical specifications & data sheet- A of cooling towers enclosed in section -'C'. In the event of any conflict between Section-'D' / data sheet-A's & section 'C', the latter shall prevail.

5.00.00 Thermal Design of Cooling Towers:

5.01.00 General

a.) **The thermal design criteria shall be as per details given below. The responsibility of CT performance shall, however, remain with the bidder in all manners and the bidder shall ensure that design offered meets the Performance requirements**

b.) The Cooling Tower Thermal design calculations shall be got vetted and approved by bidder from any of the IIT's (Indian Institutes of Technology) in the event of order along with the related CT drawings for fill arrangements etc. and charges for same shall be included in the bidder's base price itself.

c.) The Purchaser/ Customer however also reserve the rights to check the detailed calculations in the event of order and purchaser/customers interpretation shall be final in the event of any conflict.

d.) For each cooling tower thermal calculation shall be performed considering one of the end cell as standby, and all intermediate cells in operation, for arriving at the total theoretical fan power consumption.

e.) The air flow requirement shall be worked out by the formula given below.

G X H = L (T1-T2) + EvT2

Where

L = Water flow rate in Kg/hr.

T1 = Water inlet temperature to the tower in deg.C

T2 = Water outlet temperature from the tower in deg.C

Ev = Evaporation loss in Kg/hr. To compute this factor the ambient RH shall be taken as specified in technical data sheet.

G = Air rate in Kg/hr.

H = Change in enthalpy of air in KCal/Kg.

Fill for each cooling tower shall meet following minimum requirements:

a. Only virgin PVC material shall be used.
b. PVC material should be ultraviolet ray stabilized.
c. Finished fills shall be white/ light cream/ light Grey, Dark/Black. Colored fills are not acceptable.
d. Fills shall be made in easily removable sections.

5.01.00 Thermal design criteria for Counter Flow Cooling Tower:

Thermal design for counter flow cooling tower shall be done as per following guidelines:

a.) Inlet louvers losses shall be calculated using Fulkerson Methodology.
b.) For thermal design in fill zone, bidder may use fill characteristic curves and pressure drop curves duly certified by the manufacturer of the fill, bidder shall also furnish the fill equation of the fill offered.
c.) Losses through drift eliminators plenum shall be calculated using Fulkerson's methodology.
d.) Stack recovery shall be calculated as per Kelly's methodology. The fan efficiency may, however, be taken as per manufacturers tested curves subject to limit of 10% above 75% efficiency tentatively suggested in Kelly's handbook i.e. maximum permissible fan efficiency shall not exceed 82.5%.

The following exceptions are allowed for following the Fulkerson's methodology:

- Fill zone KaV/L can be enhanced @ 2% per 1 M air inlet subject to maximum limit of 10% to account for contribution of rain zone KaV/L.
- For thermal design in fill zone, bidder may use fill characteristic curves and pressure drop curves duly certified by the manufacturer of the fill.
- Thermal calculation for one no. end cells with three side open and intermediate cells with only two side open to be calculated separately for arriving at the total theoretical fan power consumption.
- The effect of head recovery, considering the recovery stack shall be taken into account while arriving at fan power consumption.

It is also clarified that above Fulkerson's methodology as specified above is the minimum acceptable method.

5.02.00 The responsibility of CT performance shall, remain with the bidder in all manners and the bidder shall ensure that design offered meets the Performance requirements (bidder may cross check the design with his own method for meeting performance requirements).

5.03.00 Fan Power Consumption (KW) and CW Pumping Head.

The total fan Power Consumption (KW) and the CW Pumping head (MWC) within bidder's terminal points shall not exceed the respective maximum limits specified in Data Sheets A.

The CW pumping head specified limit is inclusive of static head plus frictional losses including 10% margin on frictional losses.

No technical advantage shall be given to any bidder for total fan power consumption (KW) and CW pumping head (MWC) offered less than above maximum limits.

In the event of total fan power consumption (KW) or the CW pump head (MWC) offered being more than above maximum limits, the bids will be summarily rejected.

Motor rating for Fan drive shall however be kept for all the cells based on the Maximum Power.

The bidder's Cooling Tower thermal design shall take care of above aspects including maximum permissible plan dimensions indicated in Data Sheet A.

6.00.00 Specific Requirements

6.01.00 The quality of water in CW sump shall be tertiary treated sewage water. The COC in CW System shall be '3**'.** Ozone dosing to control biological/ algae is envisaged in purchaser's scope.

6.02 00 The sizing of the hot water distribution system shall be done by limiting the velocity through the pipes to a maximum of 2 m/sec.

6.03.00 a) Piping for sizes 150 NB & below shall be carbon steel as per A53 GR.B (WELD)/IS 1239 Gr. B (Heavy grade).

b) Piping for sizes 150 NB & above shall be carbon steel as per A53 GR.B (WELD)/ as per IS 2062 Gr. B rolled & welded as per IS 3589 (latest).

c) Piping for sizes 600 NB & above shall be carbon steel as per A134 GR A 283 C/ as per IS 2062 Gr. B rolled & welded as per IS 3589 (latest). Minimum pipe thickness shall be as follows:

- 6.4 mm for pipe size from 200 NB and upto 300 NB
- 7.9 mm for Pipe size from 350 NB upto 450 NB
- 8.0 m for pipe size from 500 NB and upto 600 NB.
- 10 mm for pipe size from 700 NB upto 800 NB
- 12 mm for pipe size from 1100 NB upto 1200 NB.
- 14 mm for pipe size for 1400 NB.
- 18 mm for pipe size for 2100 NB.

All pipes shall be adequately supported.

6.04.00 Buried & overground piping in bidders scope shall be protected as specified in Data sheet-A, section-D, Volume-IIB of technical specification. Welding of pipe header with Purchaser's pipe at terminal point shall be in bidder's scope. The thrust block etc. shall also be in bidder's scope.

Provision of at least 2 nos. welding sockets at cooling tower deck level shall also be in bidder's scope.

6.05.00 Manual operated B.F. valves shall be provided in hot water distribution piping such that each cell can be isolated.

6.06.00 Under each valve, flange joint & such other items prone to gland/ joint leakage, suitable trays/ channels shall be provided so that any leakage water does not spread on the surroundings. This is

also applicable for any air release valve that has to be mounted on hot water riser top. Erection of such air release valves is also to be done by the bidder.

6.07.00 Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.

7.00.00 CONTROL & INSTRUMENTATION

Cooling tower operation shall be from Unit Control Room:

7.01.00 Cooling tower Fans controls shall be from:

- Start/Stop of Fans shall be from Operator work station (OWS) in UCR.
- Start/ Stop push button shall also be provided Local to Fan drive on CT fan deck.
- The selection for local (from fan deck) or remote (UCR) operation shall be from MCC.

b) Each CT fan On/ Off/ Trip condition shall be provided in UCR.

c) Trip advice (alarm) for following shall be provided in UCR:

- Fan Motor/Gear Box vibration : "High"
- Gearbox oil level : "Low"
- Gearbox oil temperature : "High"
- CT fan Motor : “Overload”
- Any other protective feature deemed necessary for safe and reliable operation of the system and equipment.
  Alarm to be annunciated for above conditions.

NOTE: Cooling Tower MCC’s shall be located in CW pump house electrical annexe.

8.00.00 PERFORMANCE TESTING AT SITE

Cooling tower shall be performance tested at site as per ATC 105. However the performance testing shall be based on permissible ambient inlet Wet bulb temperature, Range, CW flow etc. as per CTI code.

Bidder shall arrange all instruments, duly calibrated, required for performance testing.

The bidder shall assume full responsibility for proper design & operation of each & every component of the cooling tower as well as the cooling tower as a whole.

The bidder shall submit cooling tower performance test procedure as per ATC 105 for approval in the event of order & conduct the test as per the approved procedure.

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 and design fan power consumption indicated by the bidder.

The cooling tower performance curves shall be of established design with field tests conducted elsewhere based on similar curves, bidder to furnish evidence of same. In the absence of same bidders offer is liable to be rejected.

9.00.00 The make 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 not

withstanding 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

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 (based on the performance curves). Owner reserves the right to reject the tower. In the event of its acceptance by purchaser liquidated damages as follows shall be applicable.

Sl No.	Temperature above guaranteed value	**Rates for Liquidated Damages**
1	0.1^{o}C	Rs 150 Lacs
2	0.2^{o}C	Rs 300 Lacs
3	0.3^{o}C	Rs 450 Lacs
4	0.4^{o}C	Rs 600 Lacs
5	0.5^{o}C	Rs 750 Lacs
6	0.6^{o}C	Rs 900 Lacs
7	0.7^{o}C	Rs 1050 Lacs
8	0.8^{o}C	Rs 1200 Lacs
9	0.9^{o}C	Rs 1350 Lacs
10	1.0 ^{o}C	Rs 1500 Lacs

The successful bidder shall demonstrate the above guarantees during performance testing at site.

b) The bidder shall guarantee the following, apart from other performance guarantees of the complete package.

- Total Power consumption per Cooling Tower, for the cooling tower fans.
- Total CW pumping head within the bidder's terminal point viz. static head & frictional losses for cooling tower.

c) Bidder shall submit the CW pumping head calculation along with his technical offer for reference. Any offer with pumping head more than as specified in Data sheet- A will be summarily rejected.

The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subjected to approval. CW pumping shall be calculated as follows.

The static head for calculating CW pumping head shall be considered up to top of the top most pipe on fan deck without any siphon recovery.

Frictional losses for pipes shall be as per William & Hazen formula with C = 100. Frictional losses for various valves & fittings e.g. Miter bends, valves, tees, reducers etc. shall be as per crane handbook. Ft Value for fitting friction drop calculation to be considered as 0.012 for all sizes greater than 600NB.The frictional losses shall be computed considering 10% margin on same.

William & Hazen formula: $V = 0.85 \times C \times (i)^{0.54} \times (d/4)^{0.63}$.

The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subject to approval.

d) The successful bidder shall demonstrate the above guarantees during performance testing at site.

The liquidated damages @ 8.1 lacs for each one (1) KW power consumption or fraction thereof shall be levied in the event of failure of bidder demonstrating the respective guaranteed values of KW power consumption.

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.

12.00.00 BID EVALUATION CRITERIA

The bids will be evaluated based on the cooling Tower prices quoted by the bidder and quantities of reinforcement steel & structural steel used in the cooling Towers.

The bidder shall furnish quantities of Reinforcement steel & structural steel in the Price offer.

13.00.00 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.

13.01.00 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.

13.02.00 Material identification and testing of gear reducers, regulating valve assemblies, screen assemblies, fan blades and hubs, all supporting structural assemblies, fill supports, all nuts and bolts, sluice valves, fan shafts, fills packs, gear sets, nozzles and all other applicable components constituting each cooling tower.

13.03.00 Oil leakage and oil temperature rise, backlash, noise level & amperage at full load torque with reduced speed shall be checked for each gear reducer assembly.

13.04.00 Dynamic balancing of drive shaft assembly and all other rotating components.

13.05.00 Measurement of proof strength and contour for each fan blade.

13.06.00 Static balancing test, checking of fan blade moment weight and blade track variation of fan blades, with checking of pitching and blade tip variation at site.

13.07.00 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.

13.08.00 Visual, dimensional checking of all components of each cooling tower.

13.09.00 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.

13.10.00 Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.

13.11.00 Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.

14.00.00 QUALITY PLAN:

14.01.00 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

14.02.00 The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.

14.03.00 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.

15.00.00 Tests at Site:

15.01.00 After completion of erection and commissioning of the cooling tower, Bidder 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.

15.02.00 Necessary correction curves shall be furnished by the supplier for approval along with the proposed test procedure for correcting the test results for any difference between test and guarantee design conditions.

15.03.00 All mounting and calibrating instruments required for site performance tests shall be arranged by the cooling tower supplier without any extra cost.

15.04.00 TERMINAL POINTS

a) Hot water header:-- As per the coordinates shown in the Plot Plan and at elevation as mentioned in the Data Sheet- A.
b) Cold Water Outlet Pipe Header: -- 10 Meter from edge of the respective CT basin as shown in the Plot Plan.
c) Cables & Power Cables: -- As specified in Section - C2/D2.
d) Signal Cables: -- As specified in the Section - C2/C3/D2
e) Cable Trench/cable Tray:-- As specified in the section -- C2/C3/D2
f) Instruments & Controls: --- As per in the section- C3.

16.00.00 DRAWINGS, CURVES AND INFORMATION REQUIRED:

16.01.00 The following documents only shall be furnished by the bidder with his offer:

a) Compliance certificate duly signed and stamped (enclosed herein).
b) General arrangement drawing for cooling tower, incorporating all relevant dimensions, cold water channels / sludge chamber/ screens/ gates in the cold water channel, staircase etc.
c) Pumping head calculations.
d) Thermal design calculations.

Note: The GA drawing/ calculations shall be only for reference purpose, same shall not be reviewed/commented by purchaser at this stage and shall be subject to approval only during contract).

e) Tower performance curves.
f) Guarantee Schedule duly signed and stamped (enclosed herein)
g) Technical deviation schedule (if reqd.) (enclosed herein)

Apart from above no other drgs./docs./data sheets etc. are required to be submitted at bid stage and even if furnished shall not be taken cognizance of.

17.00.00 Successful bidder in the event of award of contract shall furnish the drawings/ documents as listed in Data Sheet-C. Distribution of various documents shall be as per the Annexure to Data Sheet-C:

1.0 GENERAL INFORMATION

No. of Cooling Towers required	:	One (01)
Location	:	Out door
Duty	:	Continuous
Type	:	Mechanical Induced draft.
Counter Flow/ Cross Flow	:	Counter Flow
Fill Type	:	Film

2.0 DESIGN PERFORMANCE FOR EACH COOLING TOWER

2.1	Design Cooling water flow	:	21300 M^3**/hr.**
2.2	Inlet Air Wet bulb temp	:	23^oC
2.3	Recirculation allowance	:	0.5^oC
2.4	Design Air Inlet wet bulb temp		23.5^oC
2.5	Cold water temperature	:	28
2.6	Hot water inlet temperature	:	38 ^oC
2.7	Cooling Range	:	10 ^oC
2.8	Atmospheric conditions	:	Dusty, hot & humid
2.9	Liquid Handled	:	Tertiary treated seawage water
2.10	Total CW Pumping head permissible viz. static head plus frictional losses as below • Static head w.r.t. Min. Water level • Frictional losses within bidders T.P. with 10% margin	:	Not to exceed 9.5 MWC.
2.11	Maximum limit on total power consumption per cooling tower for the cooling tower fans at fan motor inlet terminals	:	580 KW
2.12	No. of Cells	:	No. of working Cells + (01) spare cell
2.13	Maximum permissible Evaporation loss.	:	1.65% (Max)
2.14	Maximum permissible drift loss	:	Max. 0.02 %
2.15	Design pressure for hot water distribution sy	:	5 $kg/cm^2(g)$
2.16	Max permissible Cooling Tower Plan dimensions at 'FGL' (Excluding staircase)	:	150 M X 20 M
2.17	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	120% of design CW flow.

3.0 SPECIAL FEATURES

3.1	Whether fan blades to have adjustable pitch	:	Yes
3.2	Whether fills are removable	:	Yes
3.3	Fills supported by nailing acceptable	:	No
3.3	Type of Gear box	:	Spiral Bevel - cum - Helical Type.
3.4	Gear box service factor	:	3 (Minimum)
3.5	Factor of Safety for drive Shaft	:	2 (Minimum) over the torque to be transmitted at design duty conditions.
3.6	Fan Motor rating Selection	:	Fan motor shall have at least 16% margin over the actual power requirement of gear box when the fan is working at rated duty point and at 50 ^oC Ambient temperature

4.0 Cold Water Basin Details

4.1	Finished ground level (FGL)	:	EL (-) 0.50 M (RL 901.0 M)
4.2	Maximum water level	:	EL (-) 0.30 M (RL 901.2 M)
4.3	Min. Water level	:	EL (-)1.30 M (RL 900.2 M)
4.4	Free board above Maximum water level	:	Minimum 0.3 M
4.5	Storage capacity between max and minimum water levels.	:	Min 6 Minute
4.6	Invert level of CT Basin	:	EL (-) 1.80 M
4.7	Invert level of CW channel near CT level	:	EL (-) 3.30 M.
4.8	a) Depth of Sludge pit	:	Suitable for complete dewatering of CT basin.
	b) Submersible Type sludge pumps	:	1 working + 1 standby per CT (of min cap 100 cub M/ Hr.)
4.9	Number of sludge pits	:	One
4.10	Number of cold water outlet channels	:	One for each compartment of CW basin.
4.11	Number of screens and gates in common outlet channel/Basin	:	One for each compartment of CW basin
4.12	Maximum allowable effective velocity through Cold water Outlet Screen	:	1.0 M/Sec.
4.13	Length of outlet CW Header from edge of CW Basin in CT vendor's scope	:	10 M

5.0 COOLING TOWER ROOF (TOP DECK) DETAILS

5.1	Minimum clear space required between any two fan stacks on adjacent cells	:	2.0 M
5.2	Min. clear corridor width required all along the cooling tower roof for equipment handling	:	2.0 M
5.3	Required number of stair cases from ground level to cooling tower roof	:	Two(2) viz. one at each end.
5.4	Number of cage ladders from ground floor to cooling tower top deck	:	Not required
5.5	Required number of stair cases/ ladders connecting cooling tower fan deck to Hot water distribution/ fill arrangement	:	One per cell

6.0 SCOPE OF SUPPLY :

6.1	Cooling tower basin, outlet channels/ sump and sludge pits	:	Yes
6.2	Fans with drives & Motors	:	Yes
6.3	Guards for rotating parts	:	Yes
6.4	Vibration limit switches for fans	:	Yes
6.4	Hot water piping to distribution basin	:	Yes
6.5	Isolation BFV valves at each division of HW	:	Yes
6.6	Butterfly valves on hot water distribution risers for each cell	:	Yes
6.7	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
6.8	Screen & guide for each cold water outlet sump/ channel	:	Yes
6.9	Stop log gate with guides and sealing device for each cold water outlet sump/ channel	:	Yes
6.10	Isolation valves in sludge pit	:	Yes
6.11	Drain Piping from sludge pit	:	Yes, Min 100 Mtr or to nearest surface drain.
6.12	Suitable lifting , monorail,Travelling trolley and handling arrangementfor handling each fan hub, gear reducerand motor upto one end for cooling tower top deck and for lowering from there to ground level	:	Yes, (Min 3 nos)

6.13	Capacity of Hoists shall be able to lift Heaviest portion of Fan motor assembly	:	Yes (Min - 2.0 MT)
6.14	Removable acess walkway with gratings, hand rails etc for approach from fan stack door at fan deck to fan gearbox.	:	Yes
6.15	Pulley block for lifting each screen in cold water outlet sump/ channel	:	Yes
6.16	All necessary supports, hangers	:	Yes
6.17	Base plates, foundation plates, anchor bolts, s	:	Yes

7.0 MATERIAL OF CONSTRUCTION

7.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
7.2	Casing & Superstructure	:	R.C.C
7.3	Cell partition walls	:	R.C.C
7.4	Cooling tower roof (top deck)	:	R.C.C.
7.5	Fan Cylinder/ recovery stack	:	R.C.C
7.6	Internal walk way	:	R.C.C.
7.7	Staircase	:	R.C.C.
7.8	Acess Ladder	:	HDG steel as IS 4579 (min coating of 750 gm/sq.m)
7.9	Hand rail	:	G.I
7.10	Supporting structures	:	R.C.C.
7.11	Hot water distribution nozzles	:	Polypropylene
7.12	Hot water distribution pipes	:	HDG carbon steel/PVC (IS 4985 cLass 3)/FRP/HDPE(IS 4984 PN6,Grade PE80)/or RCC/Pre-cast open trough
7.13	Hot water channel	:	RCC with RCC cover
7.14	Fills	:	PVC (Virgin & UV stabilised)
7.15	Fill support	:	R.C.C/ SS 304 Channel
7.16	Louvers	:	R.C.C.
7.17	Drift eliminators	:	PVC - UV Stabilised
7.18	Fan blades	:	FRP/GRP
7.19	Fan hub	:	Hot dipped heavily Galvanised Steel
7.20	Gears	:	Alloy Steel/ Equivalent
7.21	Gearbox and fan hub supporting structure	:	RCC/ Hot dipped heavily Galvanised Steel
7.22	Fan drive shaft	:	SS-304/ Carbon Fibre Composite material with SS 304 Coulplings
7.23	Fan drive shaft coupling	:	SS-304
7.24	Bolts, buts etc. for fan blades	:	SS-304
7.25	Hot water line valves		
	a) BF Valves	:	Design as per AWWA C504, BS-5155 Body & disc – CS IS-2062/ CI, IS210 FG260, Shaft SS-304/410. Test pressure & duration shall comply with AWWA C504
	b) Other valves		
	• Body	:	CI to IS-210 Gr. FG-260
	• Spindle & Trim	:	13% Cr. Steel.
7.26	Sludge pit isolation valves		
	• Body	:	CI to IS-210 Gr. FG-260
	• Spindle & Trim	:	13% Cr. Steel.
7.27	Sludge outlet pipe	:	CS to IS 1239.
7.28	Stop Log gate in Cold water Outlet Basin	:	2.5% Ni CI to IS 210 FG-260/CS to IS 2062 Heavily Galvanised
7.29	Guide for Stop Log gates	:	SS 304
7.30	Screen	:	SS 304 10X10 Mesh with Heavily Galvanised (as per IS: 2629) carbon steel frame and supports
7.31	Guide for Screen	:	SS 304
7.32	Bolts, buts & other hardware	:	SS
7.33	Horizontal Sludge Pumps		
	• Casing	:	2.5 Ni% Ni-Ci to IS 210 Gr. FG-260
	• Impeller	:	ASTM A351 CF8M
	• Shaft/Sleeves	:	SS-316/SS-410

Note:

a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised (610gm/Sqm in accordance wth IS 2629.)

b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.

8.0 Pipe work Painting / Protection of Pipes:

8.1 External surface:– Overground piping

a) Surface cleaning by sand blasting/wire brush/Power Tool-SSPC
b) Primer Coat- 2 Coats (Min 35 Microns each coat) of Red Oxide Zn chromate primer (conforming to IS 2074).
c) Finish Coat - 2 Coats (Min 35 Microns each coat) using Ename paint .
Total DFT=140 Microns. Final Paint shades as per IS-5.

8.2 External surface – Buried piping:

a) Surface cleaning by shot or sand blasting
b) Undergaround protection shall be provided by any one of the following:
Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnatged fibre glass. Total thickness of caoting shal not be less than 4.0 mm.

OR

With anti-corrosive tape of mimumum 4 mm thick conforming to IS-10221 and AWWA C 203-93.

c) Underground pipes shall be encased in RCC with minimum thickness of 250 mm.

8.3 Internal Painting (for Pipe Dia >1000 NB)

a) Surface cleaning by Power Tool
b) Application of one coat of epoxy resin based red oxide primer followed by adequate no of finish coats of coal tar epoxy paint to achieve total DFT of 125 to 150 microns.

9.0 INSPECTION AND TESTING

9.1	Quality Surveillance by	:	Manufacturer, BHEL and Customer
9.2	Material testing and identification	:	Required
9.3	Stage inspection to be witnessed by BHEL and Customer	:	Yes
9.4	Hydrostatic test for piping & valves required	:	Yes
9.5	Hydrostatic test to be witnessed by BHEL and Customer	:	Yes
9.6	Dynamic balancing test for each drive shaft required	:	Yes
9.7	Static balancing test for each fan and drive shaft required	:	Yes
9.8	Balancing test to be witnessed by BHEL and Customer	:	Yes
9.9	Field performance test of individual items and the cooling tower as a whole required	:	Yes

Note: Performance test of cooling tower shall be caried out at ambient temperatures close to design amb.

9.10	Field performance test to be done by	:	By Bidder
9.11	Fan performance test at shop required	:	Yes
9.12	Fan performance test at shop to be witnessed by BHEL	:	Yes
9.13	All testing instruments by supplier	:	Yes
9.14	Commissioning at site by	:	CT Vendor

11 Mandatory Spares:

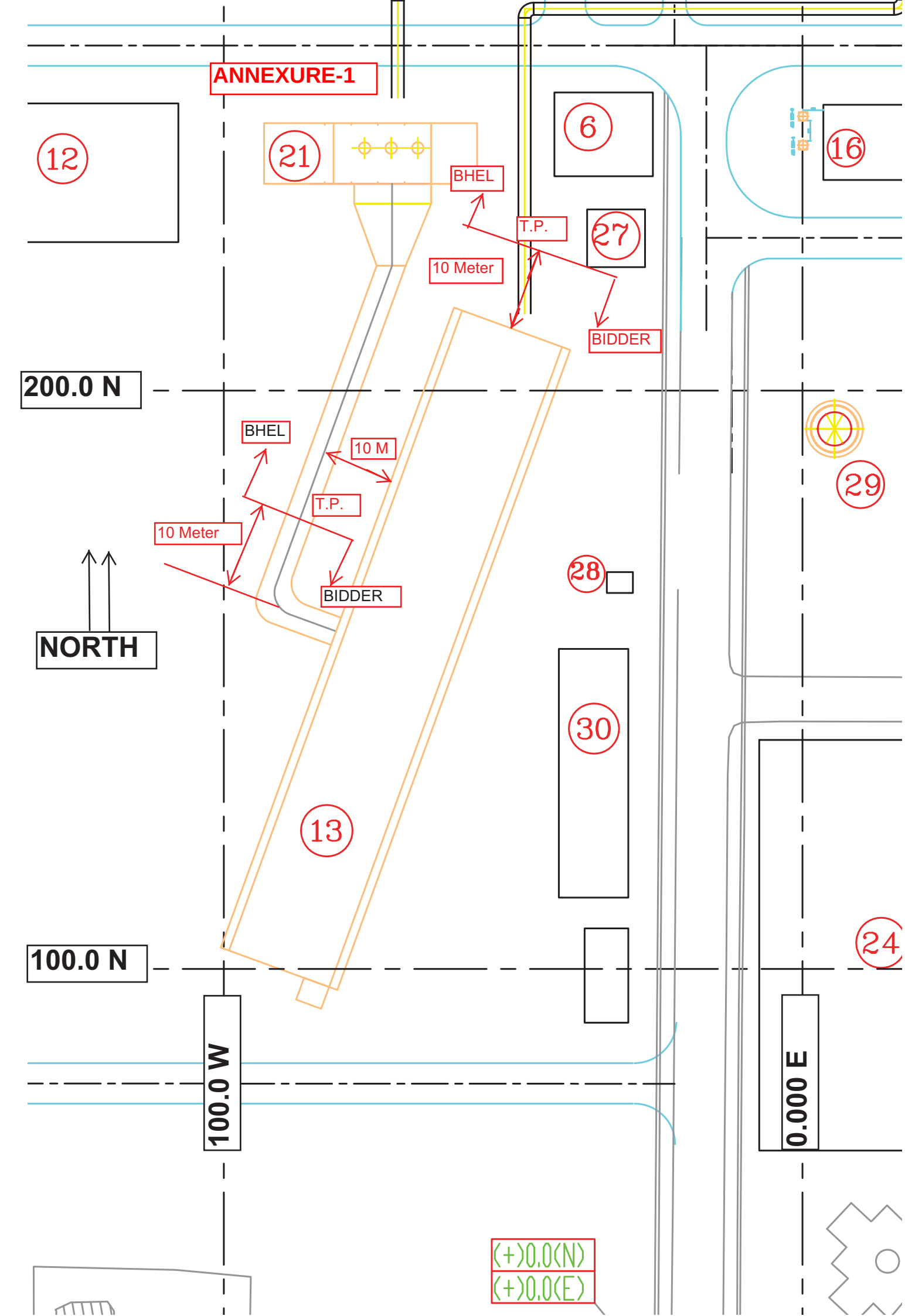
11.1 Fan bearings:---------- Two (2) Sets
11.2 Fan blade assembly:-------- One (1) Set
11.3 Motor bearings:---------- One (1) Set
11.4 Gear box assembly:-------- One (1) Set
11.5 Fan drive shaft:---------- One (1) Set
11.6 Oil seals / O-rings:---------- 50% of total requirement
11.7 Spray nozzles:---------- 10% of total requirement

10.0 Hot Water Supply Header Terminals:

As per terminal point drawing enclosed (Refer Annexure-2). CW return piping in BHEL scope (2100 NB) shall be terminated buried below ground. Further buried piping and its division into risers with isolating B.F. Valves shall be in bidder's scope.

Note: While guarantee conditions indicates design WBT of 23.5 DegC for CT design, however, CT (no. of cells and duty) shall also be designed in such a way so as to take care of the max. WBT condition of 26 DegC.

	MANDATORY SPARES		
1.0	INDUCED DRAFT COOLING TOWER		QUANTITY
1.1	Fan bearings	Set	Two (2)
1.2	Fan blade assembly	Set	One (1)
1.3	Motor bearings	Set	One (1)
1.4	Gear box assembly	Set	One (1)
1.5	Fan drive shaft	Set	One (1)
1.6	Oil seals / O-rings		50% of total requirement
1.7	Spray nozzles		10% of total requirement


ANNEXURE-1
12
21
BHEL
T.P.
10 Meter
BIDDER
6
16
27
200.0 N
BHEL
10 M
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29
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SECTION – C2

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

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

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
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	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
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/ micro processor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation dwgs by vendor. 2. BHEL will provide cable trench/cable racks/cable padestals 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 (including electronic earthing) & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage. Refer note no. 4 for electronic earthing.
9	Below grade grounding	BHEL	Vendor	MS Rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.
10	LV Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.

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

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
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, any other material required for lighting system shall also be considered by vendor in their scope. BHEL will provide the power supply alongwith LDB at one location near Cooling Tower for feeding cooling tower vendor LPs/other lighting loads. Further distribution including material is in vendor scope.
12	Aviation Lighting	Vendor	Vendor	
13	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	
14	Engineering activities 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 & Instrumentation cable schedules showing routing details [including electronic earthing cable & 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.

NOTES:

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

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 mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their civil assignment drawing.

TECHNICAL SPECIFICATION

FOR

INDUCED DRAFT COOLING TOWER

(ELECTRICAL PORTION)

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 same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Electrical load requirement for **INDUCED DRAFT COOLING TOWER**
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) 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
g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.
i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for " both end equipment in vendor's scope"shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

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 :

a) Electrical scope between BHEL & vendor (Annexure –I)
b) Standard BHEL speicification for motors.
c) Datasheets(A&C) & quality plan for motors.

d) Electrical Load data format (Annexure –II)
e) BHEL cable listing format (Annexure –III)
f) Specification & quality plans for cabling, earthing & lightning protection.
g) Specification & quality plans for lighting system.

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
	DATA SHEET-A	SECTION D
	1 X 370 MW YELAHANKA TPP	REV NO. 00 DATE 22.11.2014
		SHEET 1 OF 1

1.0	Design ambient temperature		:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor		:	200 KW
3.0	Installation (Indoors/ Outdoors)		:	As required
4.0	Details of supply system			
	a)	Rated voltage (with variation)	:	415V ± 10%
	b)	Rated frequency (with variation)	:	50 Hz + 3 % to - 5%
	c)	Combined voltage & freq. variation	:	10% (sum of absolute values)
	d)	System fault level at rated voltage	:	50 kA for 1 sec
	e)	Short time rating for terminal boxes		
		o 110 kW and above (Breaker Controlled)	:	50 KA for 0.2 sec..
		o Below 110 kW (Contactor Controlled)	:	50 KA protected by fuse
	f)	LV System grounding	:	Solidly
5.0	Class of insulation		:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting (As percentage of rated voltage)		:	(a) 85% of rated voltage
7.0	Power cables data		:	Shall be given during detailed engg.
8.0	Earth Conductor Size & Material		:	As per attached Datasheet of Earthing.
9.0	Space heater supply		:	240 V, 1¢, 50 Hz
10.0	Rating up to which Single phase motor		:	Acceptable below 0.20 kW
11.0	Locked rotor current			
	a)	Limit as percentage of FLC	:	As per IS 12615*
12.0	Flame-proof motor			
	a)	Enclosure suitable (As per IS: 2148)	:	As per requirement
	b)	Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
13.0	Paint shade		:	Shall be given during detailed engg
14.0	Degree Of protection for motor/ terminal box		:	IP 54/ IP 55

15.0 * Continuous duty LT motors up to 200 KW Output rating (at 50 deg.C ambient temperature), shall be High efficiency (IE2) as per IEC: 60034-30/ IS:12615

16.0 TESTING

16.1 Type Tests

For LT Motors above 55kW, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years from the date of bid opening shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

16.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

KARNATAKA POWER CORPORATION LTD

1X370 MW YELAHANKA CCPP

C&I TECHNICAL SPECIFICATION
FOR
INDUCED DRAFT COOLING TOWER

SPECIFICATION No: PE-TS-409-145-IXXX

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT DIVISION
NOIDA, INDIA

PREPARED BY:	CHECKED BY:	APPROVED BY:
PRAG JAIN **(Sr. Engineer-C&I)**	**Shri R.K.RAINA** **(Manager – C&I)**	**Shri M.A.MANSOORI** **(DGM – C&I)**

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SPECIFIC TECHNICAL REQUIREMENT

SPECIFIC TECHNICAL REQUIREMENTS (C&I):

1.0 Operation & Control of **INDUCED 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 the 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 / Cm2.

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 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.

7.0 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.

8.0 For instrument & control cable scope of supply refer 'Electrical scope sheet between BHEL & vendor'.

9.0 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.

10.0 The make of all the items shall be from approved sub-vendor list.

11.0 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.

12.0 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)
- 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.

• Storage and comparative analysis of vibrations.
• Generation/analysis of Bode plot/orbit plot and time waveform/ Nyquist plot etc.

All the vibration parameters as well as turbine supervisory parameters shall also be fed to the DDC MIS through software link so that all these parameters are suitably displayed on the TG control Monitor. All required I/O cards and software interface modules shall be provided for this purpose. The signals required for interlocking and protection shall be hardwired to DDC MIS.

BFP TURBINE SUPERVISORY INSTRUMENTS
The turbine supervisory equipment for Boiler Feed Pumps shall be complete including sensors, transmitters, measuring and amplifier modules, power supplies etc. along with required accessories.

Following measurements shall be provided as a minimum:
Shaft eccentricity, (both in horizontal & vertical direction) Axial shift
Differential expansion, Overall expansion, Speed (triple pick ups), Bearing metal temperature for all bearings, Stop valve metal temperature. (Also refer TD BFP TG equipment specification)

The vibration monitoring system shall acquire inputs from GTGs, STG and major 6.6 kV auxiliaries like HP/IP HRSG feed pumps.

2.16 General Guidelines for Provision of Instruments

FIELD INSTRUMENTS SHALL BE SUPPLIED AS PER AGREED PID :

- PRESSURE TRANSMITTERS
- DIFF. PRESSURE TRANSMITTERS
- DISPLACEMENT TYPE LEVEL TRANSMITTERS
- THERMOCOUPLES WITH THERMOWELLS
- RESISTANCE TEMPERATURE DETECTORS (PT 100)
- PRESSURE GAUGES
- DIFFERENTIAL PRESSURE GAUGES
- TEMPERATURE GAUGES
- LEVEL GAUGES
- PRESSURE SWITCHES
- DIFFERENTIAL PRESSURE SWITCHES
- LEVEL SWITCHES
- SIGHT FLOW INDICATOR
- OIL FLOW METER
- ROTAMETERS
- FLOW SWITCH
- ANUBAR

TECHNICAL SPECIFICATIONS FOR FIELD INSTRUMENTS, PLC, VMS, CCTV AND OTHER EQUIPMENT/SYSTEMS

- All instruments offered by the Contractor shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven as mentioned in design criteria. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications.

- The Contractor shall furnish all Instrumentation/ Control equipment & accessories under this specification as per technical specification, ranges, makes & model as approved by the Employer during detailed engineering. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/ erection of these transmitters shall be furnished, even if not specifically asked for, on as required basis. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm

Smart Electronic Transmitters for Measurement of Pressure, Differential Pressure(DP) & Flow/Level(DP Type):

- Micro-processor based indicating type (LCD display), rack mounted with accuracy of +/- 0.1% of span, Repeatability :+0.05% of FSR or better, Linearity :+0.1% of FSR or better. Hystersis: +0.1% of FSR or better. external zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4- 20 mA DC. IP 65 or equivalent degree of protection with epoxy coating, 316 SS/ haste alloy/ other suitable sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armoured capillary for corrosive and oil services, etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter. In case it becomes necessary to use a DP transmitter for pressure measurement then a 3-valve manifold should be used in place of 2-valve manifold. LVDT type is not acceptable.

- Wherever, the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application

In Detail Technical Specification:

1)Type of Transmitter: Microprocessor based 2 wire type HART protocol compatible, .

2) Accuracy : - +/- 0.1 % of span

3) Output Signal Range: 4-20 mA DC(Analog) Super imposed digital on HART protocol
4)Turn Down Ratio : 10:1 for vacuum/very low pressure applications
30:1/100:1 for other applications
5) Stability: +/-0.1% of calibrated span for 6 months up to 70 KSC &
+/- 0.25% for range more than 70 KSC(g).
6) Zero and Span Drift: +/- 0.015% per Deg.C at max. span and
0.11% per Deg.C at Minimum Span
7) Load Impedance: 500 ohm (Min)
8) Housing: Weather proof as per IP-65 with durable corrosion resistant coating
9) Over Pressure - 150 % of Max. operating pressure
10) Connection(Electrical)- Plug and socket type
11) Process Connection - 1/2 inch NPT (F)
12) Span and Zero: Continuous, tamper proof, Remote Adjustability as well as manual from instrument with zero suppression and elevation facility.
13) Accessories a) Diaphragm seal, pulsation dampeners syphon etc. as required by service and operating condition.
b) 2/3/5 Valve manifold as applicable
14 Diagnostics: Self Indicating Feature
15) Power Supply: 24 V DC +/- 10%
16) Adjustment : Calibration facility via Centralized PC based HART management system

In addition to the transmitters 6 Nos. of hand held calibrators for configuration shall be provided for maintenance of units

2.16.1 **Pressure indicators** shall be provided for

Suction and discharge lines of pumps including on header section if two or more pumps are employed for the same service and transmitters.

2.16.2 **Pressure switches** shall be provided for

(a) On all process lines / equipment where parameter abnormality / status including pre-trips alarms to be communicated to the operator in control room.

(b) For all permissives and protection conditions governed by safety operation of the equipment e.g., pressure adequate, pressure very high / low conditions.

(c) For all interlock conditions which governs starting of standby equipment or subsequent equipment for safety operation of the system.

(d) 3 switches shall be employed for protection in case of critical applications.

Inlet and outlet of filters / strainers.

2.16.3 **Differential Pressure Switches** shall be provided

(a) Across filters / strainers for remote monitoring

(b) Across condenser CW line for remote monitoring and interlocks.

2.16.4 **Differential pressure indicators** shall be provided

(a) Across filters / strainers for local monitoring.

(b) Across condenser CW line for local monitoring

2.16.5 **Pressure Transmitters** shall be provided

(a) At suction and discharge of all major pumps.

(b) For all control applications as demanded by the process. It shall be noted that for all critical control applications, 3 transmitters shall be provided.

(c) Pressure conditions of all major vessels / tanks like deaerator, hotwell, HP / IP / LP drums, etc.

(d) All inputs for equipment / unit performance calculation.

2.16.6 **Differential pressure transmitters** shall be provided for

(a) all the requirements of differential pressure, flow and level measurements.
(b) control applications.

All inputs for equipment / unit performance calculation.

2.16.7 **Temperature indicators (Thermometers)** shall be provided.

(a) On all process lines where local indication is warranted by the system either for monitoring or testing.

(b) On the inlet / outlet equipment such as heaters, desuperheaters, Heat exchangers and coolers for both the fluid media.

2.16.8 **Temperature switches** shall be provided

(a) On all process lines where parameter abnormality is to be communicated to the operator in control room.

(b) For all permissive, interlock and protection conditions governed by the safety operation of the equipment. For all critical services 3 nos., shall be provided for protection application.

2.16.9 **Resistance temperature detectors (RTD's)** shall be provided for all services where maximum temperature does not exceed 150 degree centigrade. RTD shall be 3 wire type, duplex with thermowell.

E.g., Suction / Discharge of pumps, inlet / outlet of heat exchangers, pump / motor bearings, motor windings, etc. RTD is employed for remote display, for control applications and density correction for flow measurement.

2.16.10 **Thermocouple**: Shall be provided for all services where normal operating temperature exceeds 150^0C.

(a) The element shall be duplexed integral with thermowell, K-type for temperature upto 600^0C and R-type for temperature above 600^0C.

(b) The thermocouple is employed for remote display, for control applications and density correction for flow measurements.

(c) Compensating cable shall be provided with all thermocouples as required to make the system complete.

2.16.11 **Temperature transmitters**: Shall be provided where thermocouples / RTD are used for control application. For bearing temperature, winding temperature and metal temperature, field located remote multiplexing units with digital communication to control room electronics can be considered. Otherwise, thermocouples with compensating cable to control room also can be run.

Temperature transmitters shall be mounted in marshalling cabinets in electronic cubicle room, compensating cables shall be run from the temperature element to the temperature transmitters.

2.16.12 **Level gauges:** Shall be provided on all tanks and the maximum length of one gauge glass shall not exceed 1 metre. The gauge glasses shall be stacked to cover the complete height of the tanks including over flow level. All high pressure vessel shall be provided with level gauges on either end as per Boiler statutory requirement.

2.16.13 **Level switches** : The instrument shall be provided on all equipment (storage vessel) where parameter abnormality / status to be communicated to the operator in the control room.

All permissive, interlock and protection conditions governed by the safety operation of the equipment. For all critical services, 3 switches shall be provided for protection application.

The instrument shall be external cage type with SW connection with isolation facility for surface mounted tanks and top mounted with still pipe for all sumps.

2.16.14 Level transmitters shall be provided on process equipment where continuous remote monitoring and/or control of level is envisaged.

The instrument shall be differential pressure type or displacement type.

2.16.15 Flow Glasses shall be provided at the outlet of the pipe line shall be employed under the following conditions:

Coolant from the equipment (coolers).

The instrument shall be rotary type with glass mounted for indication.
Upto 4 inch on-line flow glasses shall be supplied and above 4 inch bypass type flow glasses shall be provided.

2.16.16 Flow Switches shall be provided at different outlet header of identical equipment to alarm in the event of inadequate coolant requirement. (or) lub oil.

2.16.17 Flow elements shall be provided as mentioned below.

Orifice plate shall be provided for spray water, condensate, makeup water, LP steam/feed water. Flow nozzle shall be provided for HP/IP Feedwater, HP/IP steam, HP / LP Bypass system. The flow element connection shall be Butt welded except for DM water application where flanged connection shall be used.

2.16.18 Control valves shall be provided for all control application as required and in line with the system requirement. If the process

demands any other control, then control valves shall be provided for those applications also. Where a single control valve can not meet the turned down ratio as dictated by the process, control valves with split range application shall be provided. All bypass valves of control valves shall be suitable for inching operation and provided with position transmitters. Critical controls like feedwater control shall be provided with 100% standby control valve.

2.16.19 Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below :

(a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

(b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatic operated spray water block valve.

(c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., Pneumatically operated on-off type dampers.

2.16.20 **Valve / Damper Actuator**

All pneumatic actuators (valves / dampers) for ON/OFF and regulating services shall be complete with all accessories including the following:

(a) Hand wheel with lock.

(b) Air filter regulator.

(c) Air lock relay

(d) Pneumatic tubing from nearest air header to the actuator complete with all necessary fittings.

(e) Smart positioner for regulating services

(f) End position (open / close) limit switches.

(g) Local position indicator and non-contact type position transmitter with 2 wire, 4-20 mA DC output for regulating services.

(h) Necessary solenoid valves required for open / close operation and interlock functions.

(i) Smart position converters for the regulating services, suitable for accepting 4-20mA DC signal.

(j) Junction box near the valve for terminating the limit switch / position transmitter / E-P converter signals.

2.16.21 Smart Position transmitters shall be provided for all control valves, control damper and bypass valves / dampers, where modulating / inching operation is required.

2.16.22 Smart Positions shall be provided for all pneumatically operated control valves, control dampers, power cylinders, etc., for converting controller output of 4-20mA to 3-15 psi or interfacing with pneumatic actuators. For the service in heat proven area conventional positions shall be provided.

2.16.23 **Air filter regulators shall be provided in the :**

(a) Air supply line to valve positioners / power cylinders

(b) Air supply line to electric to pneumatic converters.

(c) Air supply line to pneumatic interlocked block valves.

(d) For each instrument rack, field instruments enclosure for purging.

2.16.24 **Analytical Instruments**

(a) **Steam and water quality measurement**

The various analytical instruments complete with their sampling system and sampling racks shall be provided for continuous monitoring of the quality of the process fluid as per Table – 1

These analysers shall be kept in an air conditioned sampling room near HRSG area.

(b) **Gas analysers**

The following gas analysers shall be provided at the location indicated below:

- HRSG stack for each HRSG: SO_2, NOx, SPM.

2.16.25 **Transmitter racks**

All the pressure, flow and level transmitters shall be grouped depending the geographical locations and mounted on transmitter racks.

2.16.26 **Junction boxes shall be provided for :**

(a) Termination of all sensors and transmitters located area-wise.

(b) Termination of transmitters mounted on the transmitter racks.

(c) Termination of both the contacts of switches and duplex elements of temperature measurement.

2.17 **Instrumentation and Control Cables**

Instrumentation and control cables and power cables shall be supplied to :

(a) Connect field instruments to marshalling cabinets in the control room through field junction boxes.

(b) Connect limit switches, torque switches, proximity switches, and position transmitters to their respective motor control centres / switchgears and marshalling cabinets through field junction boxes.

(c) Connect interposing relay contacts from relay cabinet in the control room, the motor control centres / switchgears and solenoid valves through power supply distribution board.

(d) Control desk cabling, annunciation/SER system cabling, power supply cables from distribution board to system cabinet.

Specification for cables is covered in Electrical Section.

2.18 Impulse Pipes and Fittings

Impulse pipes, tubes, fittings and air supply and signal piping / tubing shall be supplied for all the instruments under the scope of this specification as per Table 1 in this section.

2.19 Selection of Ranges for Instruments

The ranges of the instruments shall be selected based on the philosophy indicated below:

(a) For pressure and draft measurements, the maximum operating pressure shall be within 70 to 80% of the maximum scale range. All pump suction measurement will cover the negative pressure range also and all draft gauges will cover the negative pressure as well as the positive pressure as the case may be.

(b) For temperature measurement, the maximum operating temperature will be within 80 to 90% of the maximum scale range.

(c) For pressure switches and temperature switches, the set points shall fall within 40% to 70% of the scale range selected.

(d) For level measurement, the maximum of the range will cover the overflow point or six inches from the top of the vessel and the minimum of the range will be stacked with overlap to cover permissive, alarm and trip levels.

2.20 Performance Test Points

(a) Pressure, temperature and flow test points shall be provided in line with performance test code requirements

(b) Pressure test points shall be complete with root valves and shall terminate with a nipple

(c) Temperature test points shall be provided with thermowell.

(d) All instruments required for performance testing to prove the performance of the Instrumentation and Control Equipment shall be provided by the Contractor for the duration of the performance test. These test instruments shall have test certificates from reputed test house valid for the duration of the performance test.

2.21 Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 62 bar(g) OR 425^{0}C
(ii)	1	15NB	< 62 bar(g) AND 425^{0}C.
Level Measurement			
(a)	Level gauge & Switch		
Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
(i)	2	25NB	≥ 62 bar(g) OR 425^{0}C
(ii)	1	25NB	< 62 bar(g) AND 425^{0}C
(b)	Level transmitter (displacement type)		
(i)	2	40NB	≥62 bar(g) OR 425^{0}C
(ii)	1	40NB	<62 bar(g) AND 425^{0}C
(c)	Stand pipe for level measuring instrument		
(i)	2	80 NB	≥62 bar(g) OR 425^{0}C
(ii)	1	80 NB	< 62 bar(g) AND 425^{0}C
Flow Measurement			
(i)	2	25NB	≥ 62 bar(g) OR 425^{0}C
(ii)	1	25NB	< 62 bar(g) AND 425^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥62 bar(g) OR 425^{0}C
(ii)	1	25 NB	< 62 bar(g) AND 425^{0}C

2.22.3.6 Tables suitable for dot matrix/laser/inkjet printers shall be provided. The exact details shall be finalised& approved during detailed engineering.

2.23 Specifications for Instruments

2.23.1 Pressure Indicators

Direct reading, pipe mounted Pressure gauges of aluminium casing with 150 mm inch phenolic dial (white dial with black numerals), 316 SS Bourdon tube, nylon movements and micrometer type adjustable pointer, accuracy of ±0.5% of span including accessories like syphons for steam services, snubbers for pump discharge applications and chemical diaphragm for corrosive and oil services and name plate. Material of accessories will be SS. IP65 or equivalent degree of protection for enclosure. Over range protection will be 25% above maximum pressure. Armoured capillary of 15m shall be provided. Boudon tube shall be drawn tube for pressure < 70 bar (g) and bored tube for > 70 bar (g).

2.23.2 Pressure Switches

Non indicating type, field mounted Pressure Switches of aluminium casing (epoxy coated), and 316 SS element and accuracy of ±1% of span, including accessories like syphons for steam services, snubbers for pump discharge applications and chemical diaphragm for corrosive and oil services, name plate and mounting brackets. Material of accessories will be SS. Auto reset micro switch with internal adjustment for set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 or equivalent degree of protection for enclosure. Over range protection 50% above maximum pressure. Scale for setting shall be provided repeatibility shall be ± 0.5% of full scale range.

2.23.3 Pressure Transmitters

Micro-processor based **Smart Electronic Transmitters**, rack mounted with accuracy of ±0.1% of span, field zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4-20 mA DC and digital signal with HART protocol. Two nos. HART communicator with pre-loaded device program shall be provided for smart pressure / differential pressure transmitters. IP 65 or equivalent degree of protection. Aluminium housing with epoxy coating, 316 SS sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armoured capillary for corrosive and oil services. Material for accessories will be SS.

2.23.4 **Differential Pressure Indicators**

Direct reading type, pipe mounted, bellows or diaphragm operated differential pressure indicators; aluminium casing (epoxy coated) with 150 mm dial, 316 SS pressure element; accuracy of ±0.5% of span including accessories like snubbers for pump discharge application, chemical diaphragm with 15 m PVC covered SS armoured capillary for each limb for corrosive and oil services and 3 way manifold. Material of accessories will be SS. IP 65 or equivalent degree of protection. Over range protection will be 50% above maximum pressure.

2.23.5 **Differential Pressure Switches**

Bellows or diaphragm operated non-indicating field mounted type; aluminium casing (epoxy coated); 316 SS pressure element nylon movement; accuracy of ±1% of span with an adjustable contact including accessories like snubbers for pump discharge applications, chemical diaphragm with 15 m capillary for each limb for all corrosive and oil services and 3 way manifold. Material of accessories will be SS. Auto reset micro switch with tamper proof external adjustable set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 or equivalent degree of protection over range protection 50% above maximum pressure. Repeatability shall be ±0.5% FSR.

2.23.6 **Smart Electronic Transmitters for Measurement of Pressure, Differential Pressure(DP) & Flow/Level(DP Type):**

Micro-processor based indicating type (LCD display), rack mounted with accuracy of +/- 0.1% of span, Repeatability :+0.05% of FSR or better, Linearity :+0.1% of FSR or better. Hystersis: +0.1% of FSR or better external zero and span adjustment, self diagnostics, temperature sensor for compensation. Power supply 24 V DC; output signal of 4- 20 mA DC. IP 65 or equivalent degree of protection with epoxy coating, 316 SS/ haste alloy/ other suitable sensing element. Accessories like snubbers for pump discharge applications and chemical diaphragm with 15 m PVC covered SS armoured capillary for corrosive and oil services, etc. Material for accessories will be SS. HART protocol output shall be available in each transmitter.

In case it becomes necessary to use a DP transmitter for pressure measurement then a 3-valve manifold should be used in place of 2-valve manifold. LVDT type is not acceptable.

Wherever, the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

2.23.7 **Thermometers**

Indicating type, field mounted, filled system with ten (10) metres capillary and six (6) inch white dial with black numerals with micrometer pointer housed in aluminium casing (epoxy coated) with an accuracy of ±1% of span, response time of 2-4 seconds, auto temperature calibration, linear calibration over the range and 316 SS thermowell having a process connection of M33 x 2 thread. Material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Thermowell with Hex head of fabricated assembly for air and flue gas system for rest of the services bar stock assembly. The thermowell construction shall meet the ANSI 19.3 (latest) requirements.

2.23.8 **Thermowells**

Pipe/equipment mounted temperature test wells of 316 SS (SS 446 for flue gas services) with a process connection of M33x2 thread. Material of accessories will be SS. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services bar stock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermowell construction shall meet the ANSI 19.3. (latest) requirements.

2.23.9 **Temperature Switch**

Non-indicating type, field mounted, filled system with ten (10) metre capillary housed in Aluminium casing (epoxy coated) with an accuracy of ± 1% span, auto temperature calibration, linear calibration over the range and 316 SS thermowell having a process connection of M33x2 thread. Micro switch with reset type with adjustable set values with 2 SPDT contacts rated for 0.2 A, 220 V DC. IP 54 or equivalent degree of protection for enclosure. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services bar stock assembly. Material of accessories will be SS. The thermowell construction shall meet the ANSI 19.3 (latest) requirements. Scale shall be provided for setting. Repeatability shall be ± 0.5% of full scale. For ambient temperature applications switches designed for cross ambient operation shall be used.

2.23.10 **Thermocouple Assembly**

Duplex type with accuracy of ±0.5% of span, response time of 2 to 6 sec, Spring loaded mineral insulated thermocouple assembly with 316 SS thermowell housed in aluminium casing (epoxy coated) having a process connection of M33 x 2 thread. Material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Thermowell with hex head of fabricated assembly for air and flue gas system, for rest of the services bar stock assembly with ungrounded junction. For metal temperature measurement weldable thermocouple pads shall be provided with thermocouple extension wires of required length. Element size shall be 18 AWG. Insulation resistance at 540°C shall not be less than 5 M Ω. Temperature devices provided with thermowells shall be calibrated with the associated thermowell as an assembly construction and shall meet the ANSI 19.3 (latest) requirements.

2.23.11 **Resistance Temperature Detectors (RTD)**

Duplex type with accuracy of ±0.5% of span, response time 1-2 seconds; Spring loaded mineral insulated three (3) wire RTD assembly with 316 SS Thermowell housed in aluminium casing (epoxy coated) having a process connection of M33 x 2 thread. IP 54 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.12 **Temperature Transmitters Smart Electronic Transmitters:**

Temperature transmitters shall be provided where thermocouples/ RTD'S are used for control application.

Indicating type, control room mounted temperature transmitters with an accuracy of ±0.25%, ref. junction compensation, span/zero adjustment, burn out protection upscale, input/output isolation, circuit ungrounded, ambient temperature error 0.1%/10°C to provide linear output of 4-20 mA DC (2 wire system). Nema 4 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.13 **Level Gauges**

Reflex / tubular type with automatic ball check valves, illuminator, pyrex / borosilicate glass, guard rods and Holders. Material of accessories will be SS.

2.23.14 **Level Switches**

External magnetic float operated level switches for tanks and vessels and top mounted level switches for sumps and underground tanks. Micro switch with 2 SPDT contacts rated for 0.2 A, 220 V DC. Material of float will be 316 SS and the material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure.

2.23.15 **Displacement Type Level TransmittersSmart Electronic Transmitters:**

Displacement type level transmitters of float length of 14 inches or 32 inches with an accuracy of ±0.5% of span, 4-20 mA DC output (2 wire system), +24 V DC supply, isolated and ungrounded electrical circuits, zero adjustment (100% of sensing element) for control application and measurement purposes. IP 54 or equivalent degree of protection for enclosure. Displacer / float material of 316SS. The material of accessories will be SS.

2.23.16 **Flow Glasses**

Online flow glasses for pipe size up to 80 mm with a rotary wheel (not a flapper type) suitable for installation on vertical or horizontal pipe lines, material pyrex tempered glass. The material of accessories will be SS.

2.23.17 **Flow Elements**

316 SS long radius, weld in flow nozzles with D and D/2 pressure tappings; 316SS flow orifice plate assembly with flange tap connections; β ratio of 0.5 to 0.7. Element material of SS 316. The material of accessories will be SS. End connections for flow elements will be butt welded except orifice plate on condensate return line to CST which will be flanged. The flow elements shall be designed in accordance with ISO 5167 / BS 1042. The accuracy of the flow element for steam flow / feed water flow measurement shall be ± 2% or better. Unit of measurement shall be metric tonnes / hour.

2.23.18 **Air Filter Regulator (AFR)**

Constant bleed type AFR with an accuracy of ±0.1%, inlet pressure range of 5-8 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS.

2.23.19 **Electro-Pneumatic Convertors (E/P)**

Two wire type E/P convertors with an accuracy of ±0.5% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm2 air pressure to operate valve positioner of all final control elements; Housed in cast aluminium casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS.

2.23.20 **Pressure and Differential Pressure Transmitter Racks**

Open type transmitter racks to mount all pressure, differential pressure and flow transmitters with vibration damper (Keldur); air supply lines and header will be provided with bulk head fittings to receive impulse lines; Also provided with blow down/drain header. The material of accessories will be SS.

2.23.21 **Junction Boxes**

Wall/column mounted junction boxes having screwed terminals and cable entry only at the bottom and sealed with fire proof compound; The material of accessories will be SS. IP 54 or equivalent degree of protection for enclosure. Separate terminal blocks shall be used for analog and digital signals and also for signals with different voltages.

2.23.22 **Interposing Relays (IPR)**

Electro magnetic type IPRs with plug-in type connections, suitable for channel/rail mounting in cabinets; coil rating 24V D.C; 2 set of change over contacts rated for 0.2A 220 V DC. Free wheeling diode across relay coil and self reset type status indicator flag (electronic) shall be provided.

2.23.23 **System Cabinets**

Indoor located, free standing vertical type system cabinets with 3 mm thick sheet metal of cold rolled steel; double doors; antivibration pads of 15 mm thick; Fluorescent lighting; cooling fans in each cabinet fire proof compound for sealing cable entry; fire detector for each cabinet; space heater for each cabinet (strip type). Door locking facility shall be provided. Beacon lamp shall be provided in each row of cabinet to indicate the cabinet having fault condition. The racks in system cabinets shall have provision along with plug in sockets / back plane to house atleast 10% additional cards, to accommodate for engineering flexibility or future expansion.

LP feed water, LP steam,
Gland steam, Air, Fuel, Gas
and lube / control oil services

2.23.40 **240 V AC Distribution Cabinets**

The function of the 240V AC distribution cabinet is sub-distribution of 240V AC power supply from UPS to all the utilities viz., MMI and peripherals, analysers, etc. Redundant feeders will be provided for each utility. The cabinets will be free standing vertical cabinets, designed for indoor location. Material of construction will be 2 mm thick CRCA. Fluorescent lighting, fire detector and space heater will be provided for each cabinet. Isolating switches and HRC cartridge fuses will be provided for individual feeder isolation. Ammeter and Voltmeter will be provided for incoming feeders to the distribution boards.

2.23.41 **Remote I/O Units**

Remote I/O units shall be provided for acquisition and transmission through data link of signals like bearing temperature, winding temperature and metal temperature. The communication shall be dual redundant high frequency communication with measurement system. Scan rate shall be minimum 10 channels / second. The multiplexer shall be FET type / CMOS. Optical isolation to be provided. A/D converter will be 12 bit. Diagnostic features, cold junction compensation to be provided. Suitable for rack mounting in field, IP 66 degree of protection.

2.23.42 **Variable Area Flow meters (Rotameter)**

Metal body, indicating type with graduated scale, armoured, on-line mounted, accuracy of + / -2% of max. flow, rangeability of 10 to 1 main orifice and range orifice shall be provided for bypass type rotameter, IP 65 or equivalent degree of protection for enclosure. 2 Nos. adjustable switch contacts of rating 0.2A, 220 V DC. Float, float extension and body material will be SS 316 and end fitting material will be CS and scale SS 316. Type of connection shall be NPT for sizes 50 mm and below and for sizes above 50 mm ANSI 150 RF. Accessories like mounting brackets, SS metal tag, SS name plate, matching flanges with gasket, bolts and nuts, pipe assembly complete with main orifice, isolating valves (2 nos.), connecting pipe and fittings for bypass type, etc. shall be supplied. Repeatability: $\pm$ 5% full scale. On line rotameters shall be provided for line size upto 100 mm and bypass type for line size above 100 mm.

2.23.43 **Wiring, Termination and Accessories**

(a) Instrument wires: Wires carrying 4-20 mA DC or any other low voltage or current signals. Used for panel internal wiring, tinned copper conductor of 0.5 sq. mm cross section with seven strand and twisted pair with 20 twists / metre. Insulation material shall be PVC, heat resistant with flame retarding properties with thickness not more than 0.5 mm and voltage grade will be 1100 V.

(b) Control wires: Wires used for power supply like , 240V AC, 220 V DC, + 24V etc. Used for panel internal wiring, tinned copper conductor of 1.5 sq. mm cross section with seven strands. Insulation material shall be PVC, heat resistant with flame retarding properties, voltage grade will be 1100 V.

(c) Prefabricated cable: Used for interconnection between system / marshalling cabinets. Used for panel external wiring, tinner copper conductor of 0.5 sq.mm cross section with seven strands twisted pair with 20 twists / wires. Insulation material shall be PVC, heat resistant with flame retarding properties, with thickness not more than 0.5 mm . Voltage grade will be 1100 V. Each prefabricated cable shall have a minimum of 5 cores as spare and these should not be connected to end connectors.

(d) Terminal block (TB) : Screwed type, 600 grade, vertically mounted, size of 0.5 sq.mm to 1.5 sq. mm for instrument wires and 1.5 sq.mm to 2.5 sq. mm for control wires. Clearance between TBs will be 150 mm and between TB and bottom plate be 250 mm, flame resistant, non-hygroscopic, decarbonised. Insulation between adjacent terminals or between terminals and frame work will be 2 KV RMS for 1 minute - Power supply and signal TB shall be separate. Signals shall be grouped in TBs in the same order as that in junction box so as to provide neat cable layout and wiring. High voltage and low voltage signals shall be provided on separate TBs which are mounted separately. Terminal strip shall be of nylon.

(e) Termination details: Maximum of 2 wires shall be terminated per terminal. Wiring raceways, straps shall be flame retardant. All wiring shall be ferruled. Wires carrying power and signal wires shall be routed in separate raceways. Accessories like MCB, cable support, fuses, etc. shall be

supplied. Cable entries shall be cemented with fire proof compound.

2.23.44 **Desuperheater**

Desuperheaters as required for the process requirements shall be provided. End connection shall be butt welded. The liner material shall be same as that of desuperheater material.

2.23.45 **24 V DC Distribution Board**

The function of the 24 VDC distribution board is sub distribution of 24V DC power from the 24 VDC battery to all the utilities viz. DCS cabinets and all other 24 VDC requirements. Redundant feeders will be provided for each utility through diode autctioneering using diodes of high peak inverse voltage. The cabinets will be free standing, vertical cabinets designed for indoor location. Material of construction will be 2 mm thick CRCA. Fluorescent lighting, fire detector and space heater will be provided for each cabinet. Isolating switches and HRC cartridge fuses will be provided for individual feeder isolation. Ammeter and voltmeter will be provided for the incoming feeders to the distribution boards.

2.23.46 **Thermocouple Cable**

1100 V twisted pair (20 twist/metre), 1.5 sq.mm dia. thermocouple compensating extension wires, PVC insulated,aluminiummylar tape shielded/PVC jacketed/armoured and overall PVC jacketed/ FRLS. Features such as colour coding, thermo electric characteristics, etc. shall be as per ANSI STD-MC 96.1.

2.23.47 **Pneumatic Block Valves**

Balanced, on - off, plug type, single ported, gate valve. Body material shall be ASTM A 216 GR WCB with end connection socket welded for sizes 50 NB and below and butt welded for sizes above 50 NB and flow direction will be horizontal.

Bonnet: Std. type of material ASTM A 216 GR WCB and packing material GRAFOIL.

Trim: Cage guided, metal seated with flow characteristic of quick opening with stem, plug, seat and guide material of SS 316.

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1. Pressure indicators

   Calibration Hydro test (1.5 times max. pr.)

2. Pressure switches

   Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatibility

3. Differential Pressure Indicators

   Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatibility test.

4. Differential Pressure Switches

   Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatibility test.

5. Thermometers

   Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)

6. Temperature switch

   Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.

7. Resistance temperature detector assembly.

   Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity : $\pm$ 5% of wall thickness, Accuracy test.

8. Thermocouple assembly

   Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : $\pm$ 5% of wall thickness.

9. Thermowells

   Material test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)

10. Level Guages

    Hydrostatic test / Material test / Seat leakage test / Ball check test.

11. Level switches (Magnetic)

    Material test / Contact rating test / Hydro test / Calibration test.

12. Flow Switch

    Material test / Hydro static test (1.5 times max. pr.) / function test.

13. Flow glasses

    Material test / Hydrostatic test (1.5 times max. pr.) / function test.

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS (CONT'D)

14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Purchaser/Consultant.
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer Section F-14
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Drum Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :
	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test

TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS (CONT'D)

30. Interposing relay

Functional test, temperature rise test, H.V test, Insulation test

31. Transmitter Racks :

Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.

32. Local Panels :

Visual inspection, wiring & continuity check, h.v. and i.r. tests on panels, checking of bill of materials, functional tests.

Notes:

1. Test Certificates shall be furnished for all the instruments for Purchaser / Consultant's review.

ACTUATOR SPECIFICATION & DATA SHEET

BHEL	**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 800 MW KOTHAGUDAM TPS**
	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 RATED 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, 3 WIRE
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 65 ☐ FLAME PROOF

	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)
	@ 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	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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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	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	240V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	240V AC , 1 PH/415/240 V CTRL TRANSFORMER WITH PRIMARY AND SECONDARY FUSES	
	@ RATING		
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:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE: 1no., 2.5 sq. mm	
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 INTERNATION 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.

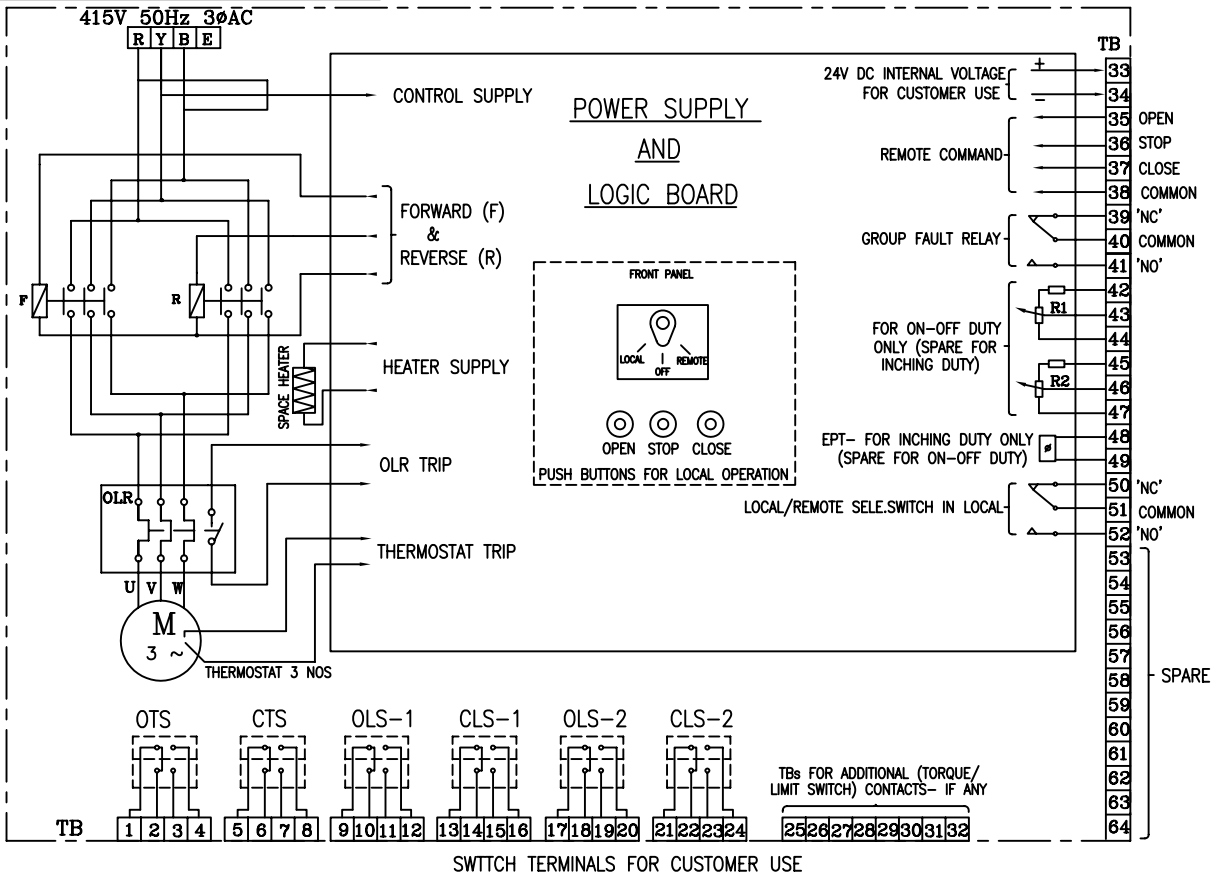
EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

	VENDOR COMPANY SEAL NAME SIGNATURE DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

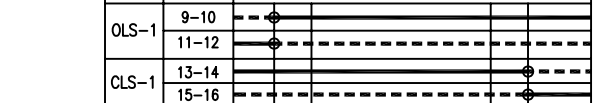
ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	



INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

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:-

1. 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
2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
6. EPT - ELECTRONIC POSITION TRAMSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M - MOTOR 3ø 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	07.10.04	
CHD	D.DINAKARAN	D.D	07.10.04	
APPD	K.ARUNACHALAM	K.A	07.10.04	

DEPT	SCALE	WEIGHT (KG).	REFERENCE INFORMATIONS	NO. OF ITEMS
VL				
CODE				

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24227

REV: 0

Size A3

Instrumentation Quality Plan

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 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 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	HYSTERISIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		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 verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. Manufacturer to carry out routine test for 100%

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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P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. 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 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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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 on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. 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			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	SEE NOTE-1 BELOW		P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY		APPROVED SPEC./ DATA SHEETS	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	

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 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 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 :

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 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 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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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. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

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 (CONTINUTY 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	

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 verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. IBR certificate to be provided, if applicable

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR MAGNETIC TYPE FLOW METER

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	
	MODEL						
	TAG No						
	VISUAL						
2	DIMENSIONS,			P	W	V	
3	PROCESS CONNECTION			P	W	V	
4	RANGE / SCALE			P	W	V	
5	ACCURACY			P	W	V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER			P	V	V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V	
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	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. Manufacturer to carry out ROUTINE TEST on 100 %.
4. 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 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	FUCTIONAL 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 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 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			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

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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. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. 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 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 :

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. When material corelation is not available, MFR's compliance to be provided
5. 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			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		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 :

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 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 SIGHT FLOW INDICATOR

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	
	MODEL						
	TAG No.						
	VISUAL						
2	DIMENSIONS,			P	W	V	
3	PROCESS CONNECTION			P	W	V	
4	RANGE / SCALE			P	W	V	
5	ACCURACY			P	W	V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER			P	V	V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V	
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	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. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

KKS PHILOSOPHY

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**.

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

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*

		N1	N2 N3
Motorised *(on/off duty)*	-	*0*	*01 to 50*
Motorised (inching duty)	-	*0*	*51 to 99*
Pneumatic (Control)	-	*1*	*01 to 50*
Motorised (thyrestor Control)	-	*1*	*51 to 99*
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

NRV (Without actuation)	-	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.

SECTION – C4

SPECIFIC TECHNICAL REQUIREMENTS (CIVIL)

SECTION D1

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR IDCT

STANDARD QUALITY PLANS

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 mechanical induced 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 Coes/ Standards refer respective Specification.

d) BS-4485.

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 upto 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 induced draft cross flow/ counter flow type having multiple cells. Number of cells in each cooling tower shall be 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.

3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A1 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 :

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 in between the cells so that one or more cells can be taken out of service without affecting the operation of capacity of other cells.

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

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 Manually operated valves shall be provided in the hot water distribution piping such that each cell can be isolated without affecting the operation of other cells.

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.

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 stationery 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 Fans & Accessories :

4.8.1 The fans shall be multiple blade, axial flow type located for each cell above the top deck level of the cooling tower and the blades shall be individually fastened to the fan hub.

4.8.2 The fan rotating assembly shall be statically balanced.

4.8.3 Each fan blade shall be adjustable as to the degree of pitch and shall be of the material as indicated in Data Sheet-A. It shall be possible to vary blade pitch angle to $\pm$ 5 degree.

4.8.4 The fan shall be connected to the drive shaft of the gear box through heavy duty flexible coupling. Suitable coupling guard shall also be provided.

4.8.5 Bolts, nuts etc. for fan assembly and mounting shall be of adequate design for the duty envisaged and shall be made of material as indicated in Data Sheet-A.

4.8.6 Each fan shall be of driven through a right angle speed reduction unit, specially designed for cooling tower service. The gear reducer shall be heavy duty, industrial design and shall adopt a service factor as specified in data Sheet-A, over fan rated BHP.

The gear reducer shall be totally enclosed weather proof design of heavy cast iron construction with outside ribs for rigidity and heat dissipation. Adequate heavy duty thrust bearings/ roller bearings and oils seals shall also be provided. The gear reducer oil shell shall be equipped with oil breather vent and shall have an oil level indicator located at accessible location.

4.8.7 Suitable means for the lubrication of gear reducer and the bearings together with suitable filler, sight glass etc. shall be provided.

4.8.8 The gears shall be spiral-bevel-cum-helical type made of Nickel Molybdenum steel and the gear teeth shall be suitably case hardened.

After heat treatment gears shall be lapped in matched sets and run under load to check accuracy of tooth contact. The complete details of heat treatment procedure for the gears shall be furnished by the vendor.

4.8.9 The drive motors for fans shall be mounted outlside the air stream i.e. outside the fan cylinder. The KW rating of the drive motor shall have at least 15% margin over maximum fan power consumption. The design and construction of the drive motor shall be in accordance with the enclosed specification for AC motors.

4.8.10 The materials of fan drive shaft shall be as per Data Sheet-A and shall be specially designed for cooling tower service. Heavy duty flexible coupling with coupling guard shall be provided at shaft ends to compensate for operating misalignment alongwith supporting bearings for the drive shaft.

4.8.11 Each fan shall be provided with an oil level indication and antivibration cut out switch suitably wired and connected as a safety device. Contact rating of the vibration switch shall be furnished for approval of the purchaser. The vibration switch shall be one no per fan. Fan will shut down on high vibration. The noise level of the fan at rated pitch and speed shall not exceed 85 dB at 50 feet.

4.9.0 Equipment Handling Arrangement :

4.9.1 A tripod with suitable chain pulley block (hoisting derrick) shall be provided for handling of the fan, gear reducer and its accessories.

In order to approach the fan, gear reducer etc. within the fan cylinder , a removable type walk

way (one no.) between the fan deck and the gear reducer, shall be provided for each cell of the cooling tower. It should be possible to install the above walkway inside the fan cylinder as and when required. A portable trolley shall also be provided for handling the mechanical equipments in and out from the fan cylinder to the cooling tower deck. The walk way is to be suitably designed for the easy movement of the portable trolley.

4.10.0 Screens & Gates in Cold Water outlet Chamber :

4.10.1 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.

4.10.2 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.

4.10.3 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.

4.10.4 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.

4.11 Vertical sludge Pumps :

4.11.1 The vertical 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.

4.12 Hardware :

4.12.1 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.

4.13 Access :

Staircases shall be provided external to the cooling tower at both ends of each tower along with stairways, landings, handrails in such number and location as necessary to give safe and convenient access to the top deck from the ground level.

4.13.2 Suitable arrangement for supporting walkways inside the cooling tower shall be made and loading of such arrangement shall be independent of the fill material.

4.13.3 Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hotdip galvanised after fabrication.

5.0 INSPECTION AND TESTING :

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 alongwith 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 PERFORMACNE GUARANGTEE, 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, cooling range, water loading of the tower. The guaranteed power consumption at the design duty of cooling tower shall also be given. If the total power consumption exceeds the guaranteed figure, the vendor shall pay penalty in the following manner.

7.4.1 No penalty is to be paid if the total power consumption does not exceed the guaranteed figure.

7.4.2 In case the power consumption measured at the motor input terminals exceeds the guaranteed figure the bidder will pay to the purchaser liquidated damages as specified in Data Sheet-A.

7.4.3 The power consumption recorded during proving trial runs shall be considered as actual consumption for computation of penalty as above.

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 TENDER EVALUATION :

The offer shall be evaluated for comparison on the following basis.

8.1 For every KW difference in power consumption of fan, loading at the rate given in Data Sheet-A shall be considered.

9.0 SPECIAL CLEANING PROTECTION & PAINTING :

9.1 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.

9.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS :

9.2.1 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.

9.3 Outside Surface of Piping (Buried) :

9.3.1 Surface treatment as specified in Data Sheet-A.

9.3.2 Coating/ wrapping/ concrete lining as specified in Data Sheet-A.

9.4 Outside Surface or Piping (Exposed) :

9.4.1 Surface treatment as specified in Data Sheet-A.

9.4.2 One coat of red oxide primer.

9.4.3 Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.

9.5 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, gear reducer, 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.

9.6 All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.

9.7 The external and internal surfaces of the tower shall also be painted.

10.0 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..

11.0 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.

DATA / DOCUAMENTS 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, endwall 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. Arrangement drawing of fan assembly drive shaft, fan hub and the gear reducer with materials of construction of different components.

8. General Arrangement and cross-sectional assembly drawings of sludge pumps and motor drives alongwith their performance curves.

9. 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 grounding system inclusive of lighting protection system.
v) 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, patitions, louvers, end walls, longitudinal beams and fan deck, fan cylinder and 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 alongwith details of tests to be conducted for the offered cooling tower.

12 Quality Plan alongwith 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.

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 1… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS		FORMAT OF RECORD	AGENCY			REMARKS
					M	C	N			D		M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10.	11.			12.
1	**RAW MATERIAL INSPECTION**														
1.1	Casting For Fan Hub Centre	Chemical Properties	Major	Chemical	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	As Cast Heat Mark Required
		Heat Treatment	Do	Heat Treatment	100%	-		Do	Do		HT Chart	P	V	V	
		Mechanical Properties	Do	Mech. test	1 sample per Heat/ HT batch			Do	Do	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg /Drg.	Mfg. Drg.		IR	P	V	V	
		Surface Defect	Do	Visual	100%	-		Approved drg./ mfg. drg.	Free from Surface Defects		IR	P	V	V	
1.2	Pipes For Spokes & Braces	Review of Mnf. TC for Chemical / Mechanical / Flattening	Major	Review of TC	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg. drg.	Mfg. Drg.		I.R.	P	V	V	
		Surface defect	Do	Visual	100%	-		-	No harmful Defects		Do	P	V	V	
1.3	BLADE CLAMP	Chemical & Mechanical Test	Major	Mech./ Chem.	1 Sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	TC	P	V		
		Appearance	Major	Visual	100 %			Mfg. Drg.	Mfg. Drg.		TC	P	V		
		Dimension	Major	Measurement	Random			Mfg. Drg	Mfg. Drg		TC	P	V		
1.4	HARDWARE	Appearance & Dimension	Major	Visual	Random			Approved Drg./ Mfg. Drg.	Approved Drg./ Mfg. Drg.		IR	P	V		Compliance Report
1.5	GLASS ROVING FIBER GLASS	Weight	Major	Measurement	100 %			Manufacturer ES	Manufacturer's ES		TC	P	V		Manufacturer T.C Shall be submitted for Review.

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-CONTRACTOR
C: MAIN SUPPLIER OF PACKAGE/SYSTEM,
N: BHEL/CUSTOMER/CONSULTANT

P: PERFORM
W: WITNESS
V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
				APPROVED BY	APPROVED BY
	Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 2… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11
		Finish & Ribonization	Major	Visual	100 %			--- DO ---	--- DO ---		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.6	POLYSTER RESIN	Physical & Chemical	Major	Review of TC & Visual	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.7	FOAM	Free – rise Density	Major	Measurement	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
2	**IN PROCESS INSPECTION**														
2.1	Welding (Hub)	WPS/PQR/WQR	Major	Qualification Verification	100%	-		ASME-IX	ASME-IX		WPS PQR	P	-	-	Refer Note - 1
		NDT on Finished Weld	Critical	DPT	100%	-		ASTM E 165	NO INDICATIONS	✓	IR	P	V	V	
			Critical	RT	10%	-		ASME SEC VIII	ASME SEC VIII	✓	IR	P	V	V	On Butt Weld between Hub & Spokes
		Dimensions	Major	Measurement	100%	-		MFG. DRG.	MFG. DRG.		I.R.	P	V	V	
2.2	FAN BLADE	Appearance	Major	Visual	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Contour	Major	Measurement	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Proof Strength/Deflection	Major	Physical Test	100 %	10%		------- DO ----------	------- DO ----------	✓	IR	P	V	V	

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-CONTRACTOR
C: MAIN SUPPLIER OF PACKAGE/SYSTEM,
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P: PERFORM
W: WITNESS
V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
				APPROVED BY	APPROVED BY
	Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 3… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11.
3	**FINAL INSPECTION**														
3.1	Hot Dip Galvanizing of Fan Hub	Surface Defects	Major	Visual	100%	-		IS:2629	IS:2629	✓	I.R.	P	V	V	HDG Supplier TC' S Shall Be Submitted For Review
		Uniformity Of Coating	Major	Dip Test	Samples as per IS:2633			IS: 2633	IS: 2633	✓	I.R./TC	P	V	V	
		Thickness / Weight / Adhesion of Zn coating	Major	Mechanical	Samples as per IS:4759- 1996			IS:4759 - 1996	Approved drg./ mfg. drg.	✓	Do	P	V	V	
3.2	FAN ASSY. (Hub & Blades)	Overall Dimensions	Major	Visual	100%	20%		Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	IR	P	W	W	
		Static Balancing	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	W	CHP
		Blade Track Variations & Tip Clearence.	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	V	
3.3	Identification & Packing	Serial Numbering	Major	Visual	100%			Mfg. Std.	Mfg. Std.	✓		P	V		
		Packing	Do	Visual	100%			Mfg. drg.	Mfg. Drg.	✓		P	V		
3.4	HUB COVER (FRP)	Appearence	Major	Visual	100%			MFG. DRG.	MFG. DRG.	✓	IR	P	V		
		Dimensions	Major	Measurement	100%			MFG. DRG.	MFG. DRG.	✓	Do	P	V		
	Note1:- Only Qualified Welders / WPS shall be used Note2:- Fan Hub will be done at manufacturer's works, Blades & Fan Assy. At manufacturer's works Note 3:-Before sending the documents for approval, supplier to ensure that 'Reference documents' and 'Acceptance norms" do contain data required for the characteristics to be checked as indicated in QP.														

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION					BHEL	STANDARD
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			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	MANUFACTURING QUALITY PLAN **NAME OF CONTRACT: STANDARD** **NAME OF CONTRACTOR:STANDARD**	**ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062** **SUB-SYSTEM:COOLING TOWER** **DATE :** **PAGE 4… OF….4**

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION						BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	MANUFACTURING QUALITY PLAN NAME OF CONTRACT:STANDARD NAME OF CONTRACTOR:STANDARD	ITEM /EQUIPMENT : DRIVE SHAFT QP NO.: PE-QP-999-165-N061 SUB-SYSTEM:COOLING TOWER DATE : PAGE… 1… OF….3

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C	N				D	M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10.	11.			12
1	**RAW MATERIAL INSPECTION**														
1.1	SS TUBE	Chemical & Mechanical Properties	Major	Chem / Mech	1 per Heat			APP DRG	APP DRG	TC	. ✓	P	V	V	
		Heat Treatment	Major	Verification	100 %			----- DO --------	-------- DO --------	TC		P	V	V	
		Leakage / NDE TEST	Major	Hydro	100 %			----- DO --------	-------- DO --------	TC		P	V	V	
		Flattening Test / Bend Test	Major	Mechanical	1 per Test			----- DO --------	-------- DO --------	TC	. ✓	P	V	V	
		NDT	Major	UT	100 %			ASTM E – 273 SEC VIII	ASTM E – 273 SEC VIII	TC	. ✓	P	V	V	
		Appearance	Major	Visual	100 %			Free from Surface Defect	Free from Surface Defect	TC		P	V	V	
		OD & Wall Thickness	Major	Measurement	100 %			Mfg Drg.	Mfg. Drg.	TC	. ✓	P	V	V	
1.2	FLANGE	Chemical & Mechanical Properties	Major	Chem / Mech	1 per Heat			Approved Drg. / mfg. drg.	Approved Drg. / mfg. drg.	TC	. ✓	P	V	V	
		NDT	Major	UT	100 %			ASTM A 609 LEVEL 2	ASTM A 609 LEVAL 2	TC	. ✓	P	V	V	
1.3	YOKE	Chemical & Mechanical Properties	Major	Review of TC	1 per Heat			APPD DRG/ mfg. drg.	APPD DRG/ mfg. drg.	TC	. ✓	P	V	V	
		Heat Treatment	Major	Review of TC	1 per Heat			------ DO -------	----- DO ------	TC		P	V*	-	
		Dimensions	Major	Measurement	100 %			APPD DRG/ mfg. drg.	APPD DRG/ mfg. drg.	IR		P	V*	-	
		Appearance	Major	Visual	100 %			Free from Defect	Free from Defect	IR		P	V*	-	
1.4	NEOPRENE RUBBER BUSHING	Appearance & Surface Defect	Major	Visual	100 %			Free from Defect	Free from Defect	IR		P	V	-	

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			DIVYANSHU ARORA	MAHEEP SINGH	VISHAL KR. YADAV		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT:STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : DRIVE SHAFT **QP NO.: PE-QP-999-165-N061**

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE… 2… OF….3**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C	N				D	M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10.	11.			12.
		Hardness	Major	Physical Test	Random			Mfg.drg.	Mfg.drg.	IR		P	V	-	
		Dimensions	Major	Measurement	Random			Mfg. Drg.	Mfg. Drg.	IR		P	V*	-	
1.5	HARDWARE SS 304	Appearance	Major	Visual	100 %			Free from Surface Defects		TC / IR		P	V*	-	
		Dimensions	Major	Measurement	Random			Mfg. Drg.	Mfg. Drg.	TC / IR		P	V*	-	
		Mech. & Chemical Properties	Major	Compliance Report	100%			Mfg. Drg.	Mfg. Drg.	Compliance Report		P	V*	-	
2	**IN PROCESS INSPECTION**														
2.1	DRIVE SHAFT FABRICATION (TUBE & FLANGE WELDING)	Over all Length of Tube & Flange	Major	Measurement	100 %			Mfg. Drg.	Mfg. Drg.	IR		P	V*	-	
2.2	WPS & PQR	Testing as per ASME SEC - IX	Critical	Review	100 %			ASME SEC - IX	ASME SEC - IX			P	V	V	
		NDT on Welds	Major	DP Test	100 %			ASTM E 165	No Indications	IR	. ✓	P	V	V	
3	**FINAL INSPECTION**														-
3.1	DRIVE SHAFT ASSEMBLY	Over All Length,	Major	Measurement	100 %	10%		Mfg. Drg.	Mfg. Drg.		. ✓	P	W	W	CHP
3.2	DRIVE SHAFT BALANCINNG	Dynamic Balancing	Major	Balancing	100 %	10%		AS PER ISO 1940 GRADE 6.3	AS PER ISO 1940 GRADE 6.3		. ✓	P	W	W	CHP
3.3	STRAIGHTNESS	Ovality & Run Out & straightness	Major	Straightness	100 %	10%		Mfg. Drg	Mfg. Drg		. ✓	P	W	W	CHP
3.4	MARKING & PACKING	Serial No. & Marking of Tube Length & Packinng	Major	Visual	100 %	-		SYSTEM SERIAL No.	SYSTEM SERIAL No.		. ✓	P	V*	-	

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P: PERFORM
W: WITNESS
V: VERIFICATION.
V* : VERIFICATION BY BHEL MAIN SUPPLIER

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD.
	DIVYANSHU ARORA	MAHEEP SINGH	VISHAL KR. YADAV	APPROVED BY	APPROVED BY

	MANUFACTURING QUALITY PLAN NAME OF CONTRACT:STANDARD NAME OF CONTRACTOR:STANDARD	ITEM /EQUIPMENT : DRIVE SHAFT QP NO.: PE-QP-999-165-N061 SUB-SYSTEM:COOLING TOWER DATE : PAGE… 3… OF….3

Note 1:-Before sending the documents for approval, supplier to ensure that ‘Reference documents’ and ‘Acceptance norms” do contain data required for the characteristics to be checked as indicated in QP.

LEGEND: . RECORDS IDENTIFIED WITH ‘TICK ‘ SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION						BHEL	STANDARD.
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			DIVYANSHU ARORA	MAHEEP SINGH	VISHAL KR. YADAV		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANNDARD
NAME OF CONTRACTOR :STANDARD

ITEM /EQUIPMENT : GEARBOX **QP NO.PE-QP-999-165-N060**

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE…1… OF….3**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D	AGENCY			REMARKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10	11.			12.
1	**RAW MATERIAL INSPECTION**														
1.1	Gear Set and internal Pinion shaft	Chemical Properties	Major	Mechanical & Chemical	1 Sample per Heat			Approved Drg./mfg. drg.		TC	✓	P	V	V	Forging Vendor TC
		Heat Treatment	Major	HT	100%	-		Approved Drg./mfg. drg		TC	✓	P	V	V	
		Mechanical Properties	Major	Mechanical Test	1 Sample per Heat/Heat Batch			Approved Drg./mfg. drg			✓				
		NDT	Critical	UT	100%	-		ASTM A 388	Refer Note # 1	TC	✓	P	V	V	
		Hardness of Teeth	Major	Hardness	1 Sample per HT Batch			Approved Drg./mfg. drg.	Not less than 50 HRC	TC	✓	P	V	V	Gear Cutting Vendor TC
		Ratio	Major	Count	100%	-		Approved Drg./ mfg. drg.	Approved Drg./ mfg. drg.	IR		P	V	V	
		Dimensions	Major	Measure	100%	-		Approved Drg./ mfg. drg.	Approved Drg./ mfg. drg.	IR		P	V	V	
1.2	Bearing	Identification & packing	Major	Visual	100%	-		Bearing Sl. No & No Damage		IR		P	V	V	
1.3	Output Shaft (Fan Shaft)	Chemical Properties	Major	Chemical	1 Sample per Heat			Approved Drg./mfg. drg.	Relevant Material Spec. as per approved drg.	TC	✓	P	V	V	
		Heat Treatment	Major	HT	100%	-		Approved Drg./mfg. drg	Relevant Material Spec. as per approved drg..	TC	✓	P	V	V	Forging Vendor TC
		Mechanical properties including hardness	Major	Mechanical Test	1 Sample per Heat/Heat Batch			Approved Drg./mfg. drg	Relevant Material Spec. as per approved drg..	TC	✓	P	V	V	
		NDT	Critical	UT	100%	-		ASTM A 388	Refer Note # 1	TC	✓	P	V	V	
			Major	DPT	100%	-		ASTM E 165	No indications	TC	✓	P	V	V	After Machining
1.4	CI casting for Gear Case & Cover	Mechanical Properties	Major	Mechanical	1 Sample per Heat			Approved Drg./mfg. drg.	Relevant Material Spec. as per approved drg.	TC	✓	P	V	V	Casting Vendor TC
		Dimensions	Major	Measure	100%	-		Approved Drg./ mfg. drg.	Approved Drg./ mfg. drg.	IR		P	V	V	

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	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
	DIVYANSHU ARORA	MAHEEP SINGH	VISHAL YADAV	APPROVED BY	APPROVED BY

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANNDARD
NAME OF CONTRACTOR :STANDARD

ITEM /EQUIPMENT : GEARBOX **QP NO.PE-QP-999-165-N060**

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE…2… OF….3**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C	N				D	M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10	11.			12.
		Surface Defect	Major	Visual	100%	-		Free from Defects	No defects	IR		P	V	V	
		Hardness	Major	Hardness	1 sample per HT batch			Approved Drg./mfg drg	Approved Drg./mfg drg	TC	✓	P	V	V	
2	**IN PROCESS INSPECTION**														
		Backlash	Major	Measure	100%	-		Manufacturer's Standard	Manufacturer's Standard	IR	✓	P	V	V	
		Overall Dimensions	Major	Measure	100%	-		Approved Drg.	Approved Drg.	IR	✓	P	V	V	
		Leakage	Major	Viisual	100%	-		No Leakage	No leakage	IR	✓	P	V	V	
3	**FINAL INSPECTION**														
3.1	Gearbox Assembly	Completion of all Previous Stages	Major	Viisual	100%	-		Approved Drg.	Approved Drg.	IR	✓	P	V	V	
		Run-in Test	Major	Vibration & Noise at no load	100%	10%		Manufacturer's Standard	≤ 127 μ & ≤ 85 dBA	IR	✓	P	W	W	
			Major	Amperage at no load torque, and full torque load at reduced RPM (77 RPM) for 3 minutes	100%	10%		Manufacturer's Standard	Manufacturer's Standard	IR	✓	P	W	W	
			Major	Oil Leakage	100%	10%		-	No leakage	IR	✓	P	W	W	
		After Run-in	Major	Temp. rise	100%	10%		-	< 45 deg C over ambient	IR	✓	P	W	W	
3.2	Before Despatch	Painting Packing & Marking	Major	Major	100%	-		Manufacturer's Standard	Manufacturer's Standard	IR		P	V	-	

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V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
	DIVYANSHU ARORA	MAHEEP SINGH	VISHAL YADAV	APPROVED BY	APPROVED BY

	MANUFACTURING QUALITY PLAN NAME OF CONTRACT: STANNDARD NAME OF CONTRACTOR :STANDARD	ITEM /EQUIPMENT : GEARBOX QP NO.PE-QP-999-165-N060 SUB-SYSTEM:COOLING TOWER DATE : PAGE…3… OF….3

Note : - 1. Normal Probe 2 – 4 MHz, 20 mm dia to be used. The Back Wall Echo (BWE) in sound area shall be set at 100% FSH. At this gain setting, any defect Echo of >20% FSH is not acceptable. Also, Loss of BWE > 20% FSH is not acceptable. Further, Defect Echo < 20% are acceptable subject to Maximum 5 such defects in a length of 1 Meter and distance between individual defec should be more than 3 times the Dia of Probe or 60 mm, whichever is higher.

:- 2. Before sending the documents for approval, supplier to ensure that 'Reference documents' and 'Acceptance norms" do contain data required for the characteristics to be checked as indicated in QP.

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			DIVYANSHU ARORA	MAHEEP SINGH	VISHAL YADAV		

SECTION D2

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

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 machnines
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.

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 mimimum 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.

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**

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.

16.0 CABLING SYSTEM

16.1 Cable Types

16.1.1 For 6.6 kV services, XLPE cables with following specification shall be provided.

6600 volts unearthed grade single or multi core, stranded aluminium conductor, screened by triple extruded semi conducting compound gas cured, gas cooled, tree retardant, cross linked polyethylene insulated, cores screened with semi conducting compound is combination with copper tape, laid up, inner sheathed with extruded PVC compound type ST2, armoured with galvanised wire or strips for multi core cables and aluminium wire armoured for single core cables and overall sheathed with extruded FRLS PVC type ST2 cable complying with IS : 7098 part-2.

16.1.2 For 415 V power supply services, space heating, outdoor lighting, lighting in the hazardous areas, power supplies to lighting panels etc., XLPE power cables with the following specifications shall be provided.

1100 volt grade, single or multi core, stranded aluminium conductor, extruded XLPE insulated, cores laid up, inner sheathed with extruded PVC compound, armoured with galvanised steel wire or strip for multicore cables and aluminium wire or strip armoured for single core cables, outer sheathed with extruded FRLS PVC compound type ST2 complying with IS:7098 pt-1.

16.1.3 For control, protection, CT/PT connections and interlocks, metering, solenoids, and for digital signals from the field devices/junction boxes/switchgears to terminal cabinets of the control system etc., with signal voltages more than 60 volts, PVC control cables with the following specifications shall be provided. 1100 volt grade, multi core, stranded annealed high conductivity copper conductor (class 2 as per IS 8130), extruded PVC compound type A insulated, cores identified by numerals, cores laid up, inner sheathed with extruded PVC compound type ST1, armoured with galvanised steel wire/strip and outer sheathed with extruded FRLS PVC compound type ST1 cable complying with IS:1554, Pt-1.

16.1.4 For low voltage digital signals to instrumentation and control system and for the analog signals, instrumentation cables with following specification shall be provided :

Single pair, multi pair or triplets or quadruplets as required, stranded tinned, annealed, high conductivity copper conductor (class 2 as per IS

8130), extruded PVC compound type-A insulated, cores identified by colour and coding, individual pair/triplet/quadruplets twisted, cores wrapped by non hygroscopic material by taping or extrusion, non metallic rip cord under wrapping, individual pair/triplet/quadruplet screened with aluminium mylar tape of 0.04 mm thick or copper tape of 0.04 mm thick or copper laminated plastic tape with 30% overlap, provided with 0.5 sq mm tinned copper drain wire for each cabling element, cabling elements suitably grouped, colour coded, cables overall screened with tinned copper wire braids of 0.15 mm dia with minimum coverage of 85% or aluminium mylar tape of 0.04 mm thick with overlap of 30%, inner sheathed with extruded PVC compound type ST1, armoured with GI wire strips/wires and outer sheathed with extruded FRLS PVC compound type ST1 complying with IEC.189-Part 1&2.

16.2 The HT & LT power cables shall be selected on the basis of current carrying capacity , short circuit rating and permissible voltage drop.

16.2.1 **Current carrying capacity**

The cable shall be able to carry the full load current of the circuit continuously under the specified ambient temperature and other conditions of installation. For this purpose, suitable derating factors shall be considered due to:

(a) Thermal resistivity of soil

(b) Ambient ground / Air temperature

(c) Derating factor for grouping of cables over the current ratings at normal conditions given in standards. The design ambient air temperature and ground temperature for this plant shall be considered as 50 deg.C and 30 deg.C respectively.

16.2.2 **Short circuit rating** :

The cables for circuit breaker controlled circuits shall withstand the fault currents for the following fault clearing times.

(a) Motor, service transformer (Protected by instantaneous over current protection)	-	0.16 seconds
(b) Tie feeders (with no IDMT relays on downstream)	-	0.5 seconds
(c) Others	-	1 second

For circuits which are protected by fuse short circuit rating capability need not be checked.

16.2.3 **Permissible voltage dip normal running** :

415V System: Voltage drop in cables between the transformer and the switchgear (PCC) or between PCC and MCC for full load current shall be limited to 2%. Further, the voltage drop in cables between PCC/MCC to the motor terminals for full load motor current shall be limited to 3% . However, these voltage drops may be adjusted in specific cases so that total voltage drop is within 5%.

16.2.4 **Permissible voltage dip during starting** :

(a) 415V system : The voltage drop during starting of individual 415V motors shall be limited to less than 15% of the full load voltage.

(b) 6.6kV system : The voltage drop during starting of BFP motors shall be limited to less than 20% of the full load voltage, for all other motors it shall be 15%.

16.2.5 Minimum conductor cross section for the power cables shall be 4.0 sq.mm aluminium or 2.5 sq. mm copper.

16.2.6 All D.C. power supply cables shall be single core cables.

16.3 **Control cables**

16.3.1 The minimum cross sectional area for control cables shall be 2.5 sq mm. However for Wiring of field device contacts (flow/level/pressure/temperature switches) to low burden circuits in annunciator relay panels, interlock relay panels, local cabinets etc., if the annunciator/ control/interlock relays are electro magnetic type, 1.5 sq.mm copper conductor can be used.

16.3.2 Current transformer leads shall be checked for lead burden, VA capacity and knee point voltage. In case 2.5 sq.mm Copper Conductor is not adequate, higher cross section cables shall be used.

16.4 **Instrumentation Cables**

16.4.1 The cross sectional area shall be 0.8 sq.mm or 0.5 sq.mm based on the requirement of I&C system employed. The minimum cross section however shall not be less than 0.5 sq mm.

16.4.2 The instrumentation cables carrying digital signals shall have overall screening and analog signal carrying cables shall have each pair screening and overall screening.

16.5 **Specific Requirements of Cables**

The following aspects are applicable for all types of cables :

16.5.1 **Core Identification**

Colour coding shall be acceptable for all cables upto 5 cores. Cables with more than 5 cores shall have printed numerals on each core.

16.5.2 Core numbers with a minimum letter size of 3 mm shall be printed serially on each core of the control cable at intervals of not more than 200 mm.

16.5.3 Core numbers with a minimum letter size of 2 mm shall be printed serially on each core of the Instrumentation cable at intervals of not more than 200 mm and each core shall be colour coded as per IEC-189 Part-2

16.5.4 FRLS PVC compound for outer sheaths of all the cables shall meet the following performance requirements and cables shall pass these tests.

(a) The critical oxygen index value shall be minimum 29 at room temperature and the temperature index value shall be minimum 250°C at oxygen index of 21 when tested as per ASTM-D-2863-77.

(b) The maximum total acid gas generation as determined by titration shall be less than 20% by weight, when tested as per IEC 754-1.

(c) The maximum smoke density rating expressed in percentage light absorption at any point on the curve during testing period shall not exceed 60 % when tested as per ASTM-D-2843-77.

(d) The cables shall pass the hydrolytic stability and ultraviolet test as per DIN 53387. The measured values of ultimate tensile strength and elongation after the test shall not be less than 60% of that measured before the test.

16.5.5 The finished cables shall pass the flammability test as per IEC-332-1and IEC-383. In addition it shall also pass flammability test as per class F3 of Swedish Standard S5-424-1475.

16.6 **Tests**

16.6.1 The Bidder shall conduct the routine tests on each drum length, acceptance and type test on the cables as per applicable standards. Also special tests for critical oxygen index, temperature index values, acid gas generation, smoke generation, flammability test, effects of light and water test as specified shall be conducted on specimen, from different batches. Routine tests shall include but not limited to the following for instrumentation cables.

16.6.2 Test for dielectric strength for one minute (as per IEC-189-1)

16.6.3 Insulation resistance test (as per IEC-189-1)

16.6.4 The vendor shall carry out following type tests as per IEC.189-1 for instrumentation cables :

(a) Tensile test
(b) Test for stripping properties of insulation
(c) Accelerated ageing test
(d) Pressure test
(e) Insulation shrinkable test
(f) Solder test on conductor
(g) Test for resistance of conductor
(h) Mutual capacitance test
(i) Capacitance unbalance test
(j) Measurement of dimensions
(k) Test for insulation resistance at 70°C
(l) Cold bend test
(m) Heat shock test.

16.6.5 **Cable carrier system**

(a) Following cable carrier system shall be adopted in various areas as indicated below.

(i) Control room building :

- Cable vault : Cable trays
- False floor : Cables to be laid on the cable support arm

(ii) Switchyard relay room

- Cable vault : Cable trays
: Cables to be laid on the cable support arms

(iii)	GTG building	:	Cable trays / conduits
(iv)	STG building	:	Cable trays / conduits
(v)	Switchyard and transformer yard	:	Cable trench
(vi)	Boiler area	:	Cable rack
(vii)	Boiler platforms	:	Cable trays
(viii)	Road / Rail crossings	:	Hume or steel pipes
(ix)	Cable carrier system connecting outlying areas	:	Cable rack or cable trenches
(x)	Off-side buildings and utilities	:	Cable trays

(b) Cable tunnels shall have minimum head room of 1.8 m considering the obstruction due to light fittings, sprinkler piping, etc.

(c) **Cable trench**

(i) Cable trenches shall be of different sizes depending on the number of cables laid in that route.

(ii) Preferred working space between the cable support arms and the wall are as follows. Contractor shall design the trenches accordingly.

Trench depth	Width of Trays	Working Space
1500 mm (5 tiers)	600 mm	750 mm
1200 mm (4 tiers)	600 mm	750 mm
1000 mm (3 tiers)	600 mm	750 mm
700 mm (2 tiers)	300 mm	350 mm

(d) **Cable trays**

(i) Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 14 gauge (2.0 mm thick) mild steel sheets. Cable tray covers shall be fabricated from 16 gauge (1.70 mm thick) MS sheets.

(ii) Cable trays and covers shall be hot dip galvanised.

(iii) In battery rooms and water treatment plant, the cable trays, accessories and covers shall be epoxy painted.

(iv) The spacing of rungs for ladder type of trays shall be not more than 250 mm.

(v) Vertical raceways shall be formed by either structural members and slotted angles or by running the prefabricated trays vertically.

(e) **Conduits & Pipes**

(i) The galvanised steel conduits shall be used for sizes upto 63.5 mm. The conduits shall be manufactured by electric resistance welding process and shall be hot dip galvanised. The conduits and fittings shall comply with IS:1653, 3837, 2667.

(ii) Galvanised steel pipes shall be used for sizes from 80mm on wards. They shall be medium duty class-B type as per IS. The pipes shall be manufactured by electric resistance welding and hot dip galvanised. The pipes and fittings shall comply with IS.

(iii) Flexible steel conduits shall be manufactured with electro galvanising process. The flexible conduits and their fittings shall comply with IS:3480, 4649.

(iv) The hume pipes/RCC pipes shall comply with IS:458.

(f) **Cable/Cable tray supports**

(i) Cable tray supports shall be fabricated from standard steel structures of different sizes. The sizes selected shall be adequate for the weight of cables/trays encountered.

(ii) The steel members shall be cleaned thoroughly for rust and painted as follows :

- For indoor - One shop coat of red oxide zinc chromate primer and two site coats of aluminium alkyd paint.
- For outdoor & corrosive areas like battery room, R.O plant - Hot dip galvanised.

(g) **Cable Carrier Installation practice**

(i) Minimum level difference between two tiers of horizontal cable trays in building, trenches, shall be 275 mm. In vertical race ways with multi-tiers the tiers shall be located atleast with 400 mm intervals.

(ii) In trenches & tunnels the width of the cable tray shall be limited to 600 mm. In case of horizontal trays it shall be limited to 800 mm.

(iii) Separate cable trays/tiers shall be provided for different voltage grade cable viz., 6.6 kV power, 415V/240V power, control cables and instrumentation & communication cables.

(iv) Cable trays shall be supported at every 1000 mm interval. Cable trenches around the transformer shall be filled with sand.

(v) Cable trays shall be welded to the mounting/carrier structures.

(vi) Vertical trays (raceways) and all outdoor cable trays shall be provided with removable 16 guage galvanised MS sheet covers.

(vii) Each continuous laid out length of cable tray shall be earthed at minimum two places by MS flats of minimum size 25mm x 3mm, the distance between earthing points shall not exceed 10 metres.

(viii) When cables are taken in vertical raceways /trays and they pass from one floor & other floor pipe sleeves in concrete shall be provided.

16.7 **Cable Installation**

16.7.1 Cables to each circuit shall be laid in one continuous length. Cable jointing and splicing shall be avoided. Jointing will be allowed only for the cases where the route length is more than the maximum possible drum length.

16.7.2 **Outdoor cable installation**

(a) Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in hume or steel pipes. For road crossings, the pipe for the cable shall be buried at not less than 600 mm. Hume pipes shall be preferred to steel pipes from the point of view of corrosion.

(b) The cables shall be tied to tray rungs by means of 3mm dia. nylon cord at an interval of 5000 mm and also at bends.

(c) For good sealing arrangement at entry points, suitable pipe sleeves, adequate in number and of adequate sizes shall be provided in building walls/slabs for passage of cables into a building from cable trays/racks/cable trenches located outside the building.

16.7.3 **Cables in Trays / on Racks**

(a) Different voltage grade cables shall be laid in separate trays. When trays are arranged in tiers, HV cables shall be laid in top trays and cables of subsequent voltage grades in lower tiers of trays.

(b) The HV power cables shall be laid in trays/on racks as follows :

i) In single layer only without exception.

ii) 3 core cables to be laid in touching formation.

iii) Single core cables to be laid in trefoil groups.

(c) 1100V grade power cables of 120 mm² size and above shall normally be laid in single layer in trays/on racks.

(d) Smaller 1100V grade power cables below 120 mm² may be run in double layers, where required, due to space restrictions.

(e) Control and instrumentation cables can be laid upto a maximum of three layers in each tray/rack.

(f) Single core power cables for 3 phase AC circuits laid in trays/racks/ trenches in trefoil groups shall be held in trefoil clamps placed at an interval of 3 m. The trefoil groups of cables shall be additionally tied by means of 3 mm dia. nylon cord as follows :

(i) At an interval of 1m when laid in cable trays/racks.

(ii) At an interval of 750 mm when laid in trenches without cable trays.

(g) Control cables and small power cables on racks shall be run in ladder type cable trays supported on rack carrier arms. The cables shall be tied to tray rung by means of 3 mm dia. nylon cord at an interval of 5000 mm and also at bends.

16.7.4 **Bending radii for cables**

The bending radii for various types of cables shall not be less than those values specified by the cable manufacturer.

16.7.5 **Terminations, clamping and miscellaneous details**

(a) Cable entry to motors, push button stations and other electrical devices shall be from the bottom as far as possible or from the sides. Top entry shall be avoided particularly for outdoor equipment.

(b) Identification tags made from aluminium sheet shall be attached to each end of each cable by means of GI binding wire. Tags shall be additionally put at an interval of 30 metres on long runs of cables and in pull boxes.

(c) All cable terminations shall be done with solderless crimping type lug. Cable terminations shall be done with double compression type brass cable glands.

(d) Saddle type clamps to suit number of cables to be clamped at a particular location shall be used for clamping cables running along walls, ceilings, structures, etc. at 750mm interval.

16.7.6 H.T.cable termination shall be of heat shrinkable type.

16.7.7 **Testing and commissioning of cables**

(a) Cables shall be checked for insulation resistance before and after jointing.

(b) High voltage testing

All cables of 1.1 kV grade 400 mm² and above and all HV cables shall be subjected to DC or AC (preferably DC) high voltage test after terminating but before commissioning as per Table 4 in IS:1255.

16.7.8 **Earthing**

(a) Metallic sheaths, screens and armour of all multicore cables shall be earthed at both equipment and switchgear end.

(b) Sheath and armour of single core power cables shall be earthed at switchgear end only. For long lengths of cables multiple earthing may have to be adopted to safeguard against the presence of standing voltages under normal as well as fault conditions.

16.7.9 **Fire proof sealing system (FPS)**

(a) Fire proof sealing system shall consist of

(i) Fire-stops/fire-seals for sealing of cable/cable tray and conduit/pipe penetrations, both horizontal and vertical, through brick or RCC walls/floors, to prevent the spread of fire from one area which is separated from others by fire-resistant barriers.

(ii) `Fire-breaks' provided on long runs of cable racks/trays to prevent the propagation of fire along the cable rack, within a single fire-area or fire- zone.

(b) The FPS system shall also include all the necessary accessories and equipment required for supporting, holding in position, fixing and installation of the fire-stop/fire-break.

(c) The FPS system shall comply in all respects with the requirements of the codes and standards listed below

IEEE-634, ASTM-E-814, ANSI-IEEE-383, IEC-331& IEC-332

(d) Fire Stop/Seal

The FPS system adopted for cables or cable trays penetrating through walls and floor openings, or cables passing through embedded conduits/pipes/ pipe-sleeves, constitutes a `fire stop/seal', which is meant to prevent spreading of fire between areas separated by fire-resistant barriers.

(e) Fire Break

The fire proofing system, other than fire-stops, adopted to retard flame propagation along long runs of horizontal or vertical cable trays in the same fire zone or area, in an event of a fire, shall constitute a `fire-break' and shall be provided by applying a suitable fire-resistant coating on cables and cable trays for the required length, with or without a fire resistant panel, at the point of the fire break to obtain the fire-rating specified.

(f) Performance Requirements

(i) Requirement of fire stops

- The material, design and construction of the fire stops shall be such as to provide the fire-rating of 120 minutes for a fire on any side and meet all requirements listed in this specification and the relevant codes and standards.
- The materials used in the fire stops shall be non-hygroscopic, compatible with the type of cables.
- The fire stops shall be suitable for retrofitting of cables through the penetration seal without disturbing the sealing of the cables already existing.

(ii) Requirements of fire breaks

- Each fire break shall have a fire-rating of 30 minutes and shall be capable of withstanding for the duration specified, a fire on any side of the fire break.

(g) Application of fire proof sealing system

(i) Fire stops

Fire stops shall be provided for cable penetration openings listed below

- The passage of cables/cable trays pipe sleeves/embedded conduits through walls / floors.
- Vertical raceways which carry cables between successive floors, through openings provided in the RCC floor slab, shall be sealed by fire stops at each floor level.
- Cable entry through openings in floor slabs below HT/LT switchgear, MCCs, various control and relay panels and other bottom entry panels, shall be effectively sealed by fire stops.

(ii) Location of fire breaks

- Fire breaks shall be provided on both cable rack and trenches at all cable tray intersections and tee-offs.
- On linear runs of cable trays between fire stops or fire breaks, fire breaks shall be provided at intervals of 15 metres on horizontal cable runs and 5 m on vertical cable runs.
- Fire breaks in linear runs of cable trenches between intersections and tee-offs shall be provided at intervals of 30 metres.

16.7.10 Contractor shall furnish the test certificates for the fire stops and fire breaks after award of contract for Owner / Owner's Representative review. If the certificates are not satisfactory all the tests shall be conducted free of cost. The offered system i.e. fire stops and fire breaks shall be identical (or better) with the system which is successfully type tested for the specified rating i.e. the composition density of the material, thickness of coating in case of fire breaks and any other properties of the material / system offered shall be identical or better than the tested system and shall be subject to Owner / Owner's Representative approval.

16.7.11 **Performance Tests: Tests on Fire Stops**

(a) The fire stops shall be subjected to the following type tests :

(i) Fire Rating Test

(ii) Hose Stream Test

(b) Type tests shall be conducted on different fire stop test specimens described above as per IEEE-634. The sizes of the fire stop test specimens, shall be similar to the largest of the sizes being used in the plant.

(c) Preconditioning of fire stop test specimens

Before conducting the fire rating and hose stream tests, each test specimen shall be preconditioned for thermal ageing, water immersion and vibration.

(d) Test on Fire Stops

During the fire rating test, the transmission of heat through the cable penetration fire stop shall not raise the temperature on its unexposed surface above the self ignition temperature of the outer cable covering, the cable penetration fire stop material, or material in contact with the cable penetration fire stop, with a maximum temperature limit on the unexposed surface of 200^{o}C.

(e) Tests on fire breaks

Fire breaks shall undergo the following tests as per ANSI-IEEE-383 :

(i) Ampacity test

(ii) Flame test

18.0 EARTHING SYSTEM

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

18.1 DESIGN CRITERIA

18.1.1 Fault Current & Duration

The earthing conductor shall be designed for 40 kA for a duration of 1 second.

18.1.2 Conductor Material

The earthing system conductors and accessories as proposed are to be as follows :

(a)	Conductors above ground level and in trenches	:	Galvanised steel
(b)	Conductors buried in ground or embedded in concrete	:	Mild Steel
(c)	Electrodes	:	GS Pipe / Rod
(d)	Lightning protection air termination and down conductors for buildings	:	GS Flat
(e)	Exposed lightning protection air termination on chimney top	:	Lead coated copper

The Bidder shall undertake the soil resistivity measurements at site and select suitable type of conductors.

18.1.3 Size of Conductors

(a) **Main Earthing Conductors**

The earthing conductor sizes shall be calculated IS 3043 and shall comply with Indian Electricity rules and IEEE-80.

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

RESISTIVITY OF SOIL OHM– METRIC		Reduction in thickness/diameter, mm
	<10	8.0
>10	<25	7.0
>25	<50	5.5
>50	<75	4.5
>75	<100	3.0
>100		1.5

(b) **Rod Electrodes**

Galvanised steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class – C) GI pipe of suitable diameter with perforations. Electrodes installed in the test pits will have disconnecting facilities.

(c) **Equipment Earthing Leads**

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043.

(d) **Conductors for lightning protection system**

The size of conductors for lightning protection system shall be decided based on mechanical strength.

18.2 EARTHING SYSTEM LAYOUT

18.2.1 The earthing system design and installation shall generally comply with IS-3043, IEEE-80 and Indian Electricity Rules.

18.2.2 **General**

(a) Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system. Two earthing leads shall be used if rated voltage of equipment is above 250V. If the rated voltage is 250V or below, one earth lead shall be provided. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

(b) Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

(c) All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

(d) Each side of the generator neutral earthing resistor shall be terminated at two nos. treated pipe earth electrodes. The earth pipe electrodes shall be further interconnected to the buried earth grid.

(e) Neutral of the auxiliary transformers shall be directly connected to two nos. treated pipe earth electrodes.

18.3.3 Earthing Conductor Layout in Switchyard

(a) Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

(b) The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

(c) Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. Fence grounding shall be done separately without connecting it to switchyard earthing grid.

(d) An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.

(e) Each earth leads of transformer neutral, lightning arrester earth leads, CVT's earth leads shall be directly connected to two separate electrodes. Lightning protection down conductor shall be directly connected to a separate earth electrode. All earth electrodes in turn shall be connected to station earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

18.3.4 **Earthing Conductors Inside Building**

(a) Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover.

(b) In case, the building has more than one floor, each floor shall be provided with earth grid. Floor earthing grids shall be interconnected.

(c) Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.

(d) Cable trays, steel pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

(e) Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment.

(f) Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

(g) Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

18.4 **EARTHING SYSTEM INSTALLATION**

18.4.1 The spacing between two electrodes shall be atleast equivalent to twice the length of the electrode.

18.4.2 Earthing conductor running exposed on column, walls, etc., shall be supported by suitable cleating, at intervals of 750 mm.

18.4.3 The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.

18.4.4 When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall sealed after installation.

18.4.5 The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.

18.4.6 Metallic conduits, and pipes shall not be used as earth continuity conductor.

18.4.7 Street lightning poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.

18.4.8 Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc..

18.4.9 Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound.

18.4.10 Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

18.4.11 The cable sheaths, screens armour shall be earthed at both ends for multi-core cables. For single core cables the same shall be done at one end (switchgear end) only.

18.4.12 All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

18.4.13 Alternate switchyard fence posts shall be connected to the earth grid.

18.5 LIGHTNING PROTECTION SYSTEM

Lightning protection system shall consist of vertical air termination rods, horizontal roof conductors, downcomers, and pipe electrodes.

18.5.1 Need for Protection

The need for providing the lightning protection system shall be established by calculating risk index value for each building structure, etc., as per procedure given in IS-2309 and any building whose risk index is more than 40 (Probability of being struck/Acceptable risk) shall be provided with lightning protection.

18.5.2 Lightning Protection System Layout

(a) The lightning systems design and installation shall generally comply with IS:2309 code of practice for the protection of building and allied structure against lightning.

(b) For stack air termination, rods interconnected by circumferential conductors will be provided at the apex of flue and also upon outer shell of the stack. The air termination system will be formed by lead coated copper conductors to prevent corrosion of conductors due to flue gas.

(c) For cooling towers, air termination system will comprise of horizontal circumferential conductors at the top.

(d) For switchyard down conductors from the shield wires shall be run along the tower and connected to rod / electrode. The zone of converage for the shield wires and 45^0 on end conductor. shall be considered as 60^0 between two

(e) Each down conductor shall be connected to a rod electrode which in turn shall be connected to the station earthing system through test links.

18.5.3 **Lightning Protection System Installation**

(a) Conductors of lightning protection system shall not be connected with conductors of safety earthing system above ground level.

(b) The down conductors shall be welded to steel structures at 1000 mm interval or cleated to wall at 750 mm interval. Wherever welded, the weld locations shall be treated to provide rust protection.

(c) Each down conductor shall be provided with a test link at a height of about 1000 mm above ground level.

(d) All the metallic structures within a vicinity of 2000 mm shall be connected to the lightning protection conductors.

17.0 LIGHTING SYSTEM

Lighting system shall be provided for the entire plant covering all the buildings, outdoor areas, roads, yards, boundary, etc.

17.1 Categories of Lighting

17.1.1 The plant lighting system shall comprise the following four (4) categories :

(a) Normal 240 V Single phase AC lighting system

(b) Normal-cum-Emergency 240 V Single phase AC lighting system

(c) Emergency 220V DC lighting system

(d) Maintenance 24V AC lighting system.

17.1.2 **Normal 240V AC lighting system**

In this system, the lighting circuits shall be fed by the 3 phase, 4 wire normal AC supply available from the normal lighting distribution boards. All the lighting fixtures connected to this system shall be available as long as supply is available from normal source viz., auxiliary transformer.

17.1.3 **Normal cum emergency 240V AC lighting system**

Certain lighting fixtures considered essential shall be connected to this system. In this system the lighting circuits shall be fed from another lighting distribution board from normal/emergency section of the 415 V main switchboard. The lighting fixtures connected to this system will be available whenever normal supply is available in the plant and also whenever emergency DG set supplies the power to this bus section during blackout conditions. During blackout conditions, the lighting fixtures connected to this system will go off and shall come back as soon as the DG set starts feeding power to the 415 V normal-emergency bus section.

17.1.4 **Emergency DC lighting system**

(a) During station emergency involving total AC failure, incandescent lamp DC lighting fixtures shall be provided for movement of personnel in TG buildings at strategic locations viz., near entrance, staircase, landings etc. and for lighting the control room and emergency DG set area.

(b) These fixtures shall be connected to lighting panels supplied from 220V DC station battery in the TG building. These lighting fixtures shall be normally `Off' and shall automatically get switched on the moment AC power supply fails. When power supply is restored they shall be switched off manually. In pump houses, out lying areas the fixtures shall be `Instalite' type which is permanently connected to normal supply charging a battery and switches on automatically once AC power supply goes off.

17.1.5 The area-wise distribution of lighting fixtures connected to the systems discussed above shall be as follows :

Area /Building	Percentagewise distribution of Lighting		
	Normal	Normal & emergency	220 V DC
GTG/STG control room buildings	80%	20%	*
Switchyard relay room	80%	20%	*
Switchyard and battery rooms	80%	20%	
Transformer area & switchyard	100%	-	-
Pump houses	80%	20%	*
Roads	100%	-	-

* Adequate for personnel movement and also located at stragetic locations.

17.2 **Lighting Supply Distribution System**

17.2.1 **Normal and normal emergency AC systems**

(a) For these systems, the distribution shall be by 415 V, 3 phase, 4 wire, 50 Hz supply with effectively earthed neutral. This supply shall be derived from 415 V, 3 phase, 3 wire, 50 Hz unit service switchgear by providing a 415/433 V delta/star lighting transformer. The secondaries of lighting transformers shall be connected to 415 V 3 phase, 4 wire, AC lighting distribution boards (LDBs). The LDBs will be provided with number of outgoing circuits controlled by MCBs to feed the lighting panels distributed in and around the plant as well as to directly feed three phase street lighting and yard lighting supplies.

(b) AC lighting panels shall have 1 phase, 2 wire incomer and number of 1 phase outgoing circuits controlled by MCBs. Lighting panels feeding the Lighting fixtures in indoor areas shall be controlled from the respective lighting panels located in various buildings in the plant. Road, yard lighting and aviation warning lights also shall be contactor controlled. The control of all such lighting shall be done automatically through multi-programmable timer units. Also manual switching `on and off' facility shall be provided.

17.2.2 220V DC lighting system

Emergency DC lighting supply distribution shall be on 220V DC, 2 wire unearthed system. This power supply shall be obtained from station 220V DC switchboard. DC lighting panel shall be provided for distribution of lighting supply. This panel shall have an incoming switch, undervoltage relay and number of outgoing circuits controlled by switch fuses. No voltage at the normal emergency switchgear shall be sensed and DC contactor shall be switched on thus extending DC supply to the lighting circuits.

17.3 Illumination levels and choice of lighting fixtures

The area-wise distribution of average illumination levels and type of luminaires shall be as given below.

Sl. No.	Area/ Structure	Average Illumination Level in Lux.	Type of Fixture	Type of Luminaire
1.3.1	**GTG,STG Building / Switchgear building**			
(a)	General (auxiliary equipment areas)	200	Industrial well glass vitreous enamel reflector integral mounted control gear/industrial bulk head with integral mounted control gear	1 x 70 W / 1 x 150 W HPSV lamp
(b)	Cable vault	100		
(c)	All switchgear room area (including off-site building control room)	250	Industrial type with vitreous enamel reflector	2 x 28W fluorescent lamp (T5)
(d)	GTG Building operating floor	250	Industrial high bay with anodised aluminium reflector	1 x 250 W HPSV lamp
(e)	Control room, SWYD. Relay room	300	Decorative recessed with wide angle mirror optic anti glare type	2x28 W F.L.(T5)

Sl. No.	Area/ Structure	Average Illumination Level in Lux.	Type of Fixture	Type of Luminaire
(f)	Battery rooms	150	Vapour proof	2x 28W F.L.(T5)
(g)	A/C plant room	150-200	Totally enclosed vapour proof with clear acrylic cover	2 x 28W(T5)F.L
(h)	Unloading and maintenance bay	250	Industrial high bay	250W HPSV lamp (for mounting height > 9 m)
(i)	Electrical / Instrument laboratory, chemical laboratory (air-conditioned)	250	Decorative recessed with wide angle mirror optic anti-glare type	2x 28W F.L.(T5)
(j)	Chemical laboratory (non-airconditioned)	250	Corrosion proof	2 x 28W F.L.(T5)
1.3.2	**HRSG area**			
(a)	HRSG area and platforms	Grade level 50-150	Dust proof / dust tight well glass fixture	70W HPSV lamp
1.3.3	**Transformer Area**			
(a)	General	10-20	Flood light medium beam type	1 x 150W HPSV lamp
(b)	Near equipment	30-35	Dust proof / dust tight well glass on fire partition walls	1 x 70W HPSV
1.3.4	**SWYD Area**			
(a)	General	10-20	Flood light medium beam type	1 x 150W HPSV lamp
(b)	Near equipment	30-35	Substation lantern with prismatic glass reflector	1 x 100/200w GLS
1.3.5	**Various Off-site building**			
(a)	Equipment room (All pump house)	250	Industrial type with vitreous enamel reflector upto mounting height of 8M OR	2 x 28W F.L.(T5)
(b)	Outside working areas	70	Flood light medium beam	250W HPSV lamp
1.3.6	**RO Plant**			
(a)	General	250	Corrosion proof	1 X 70 WHPSV

Sl. No.	Area/ Structure	Average Illumination Level in Lux.	Type of Fixture	Type of Luminaire
1.3.7	**Road and yard lighting**			
(a)	Main Roads Secondary roads	15 10	Street light with clear acrylic cover cut-off type with integral mounted control gear	1 x 70W HPSV
(b)	Perimeter (compound) lighting	10 – 20	- do -	- do -
(c)	Parking area	50	General purpose flood light, high/medium beam flood light	1 x 250 W HPSV
1.3.8	**Workshop building**	300	Industrial type with vitreous enamel reflectors/industrial high bay	2x28W F.L(T5)/ 250 W HPSV
1.3.9	**Administration Building**			
(a)	Main office areas cabins (air conditioned areas)	200-250	Decorative recessed type with mirror optic reflector	2 x28W F.L.(T5)
(b)	Main office areas, cabins with false ceiling but non-air-conditioned	200-250	- do -	- do -
(c)	Main office areas, cabin non air-conditioned areas without false ceiling	350	Decorative with wide angle mirror optic reflector	- do -
(d)	Warehouse, canteen, medical centre	100 – 150	Industrial type with vitreous enameled reflector/industrial medium bay with anodised aluminium reflector	2 x28W F.L.(T5)
1.3.10	**General**			
(a)	Corridors, walk-ways, staircase, etc.	150	Industrial type with vitreous enamel reflectors/channel mounted box type compact flourescent lamp	2 x28 W F.L.(T5)
(b)	Lockers, toilets, wash rooms, etc.	100	Channel mounted box type	- do -
(c)	Building periphery lighting	-	Industrial well glass with integral mounted control gear/industrial bulk head with integral mounted control gear	1 x 70 W HPSV lamp

Sl. No.	Area/ Structure	Average Illumination Level in Lux.	Type of Fixture	Type of Luminaire
1.3.11	**Elevator**			
(a)	Elevator machine room	100	Industrial type vitreous enamelled reflector	2 x28W F.L.(T5)
(b)	Elevator well	20	Industrial bulk head/ industrial bulk head with integral mounted control gear	1 x 100 W incandescent lamp / 1 x 70W HPSV
1.3.12	**DC Light Fitting**			
(a)	Control room	-	Decorative recessed type with cylindrical reflector	1 x 100 W incandescent lamp / CFL lamp
(b)	Other areas	-	Industrial bulk head or industrial well glass with reflector	1 x 100 W incandescent lamp

The illumination levels for areas which are not specifically covered above shall be decided based on illumination levels indicated for similar areas or in relevant standards.

Note : All fluorescent lamps shall be with low loss electronic ballasts.

17.4 Lighting System Design

The lighting system design shall comply with the acceptable norms and the best engineering practices. The system design shall consider principles of lighting specified in following paragraphs. The lighting layout shall be designed to provide uniform illumination with minimum glare. The layout design shall meet all the statutory requirement, local rules etc.

17.4.1 Indoor lighting

The illumination level for various areas in the plant are indicated in the Table above. Following factors shall be considered while arriving at the utilisation factor to determine the number of fixtures for each area/building in the plant.

(a) Maintenance factor

(i) Control room and system cabinet room - 0.8

(ii)	All other indoor areas	-	0.7
(iii)	Out door areas	-	0.6

(b) Reflection factor for wall and ceiling

(i)	Control room and system cabinet room ceiling,	-	0.7 0.5 wall
(ii)	Other areas ceiling 0.3 wall	-	0.5

(c) The value of the ratio of spacing (S) to mounting height (H) shall be commensurate with the type of fittings selected, uniformity of illumination. The suspension height for suspended fixtures shall not exceed 1 metre.

17.4.2 **Roadway lighting**

(a) Lighting design for roadways shall consider a maintenance factor of 0.6 for average conditions.

(b) Ratio of minimum to average illumination shall not be less than 0.3. The road lighting layout shall consider the width of the road to decide whether the lighting poles shall be located on one side, on either side or in the central reserve.

(c) The mounting height of the luminaires shall be generally 9 metres.

(d) The control gear for street light shall be of non integral type i.e., the control gear of the light fixture shall be mounted at the foot of the pole.

17.4.3 **Selection of lighting fixtures and accessories**

The type of luminaires and accessories like switches, receptacles etc., shall be selected based on the plant area in which they are intended to be used.

17.4.4 **Switches and receptacles**

(a) In the plant areas, the lighting circuits shall be controlled directly from the MCBs in the lighting panels. Wherever the lighting panel

is not in the same area, separate switches shall be provided. For cabins, rooms etc., separate switches shall be provided for each point. Similarly for entrances, building periphery lighting separate switches shall be provided.

(b) 240V, 50Hz, 3 pin power receptacles (5 A and 15 A) shall be provided in all building/areas of the plant. Also inside a building, receptacles shall be provided at regular intervals so that any point of the building is not more than 10 m with a minimum of 2 nos., in an enclosed area. Inside each cabins atleast two receptacles shall be provided. The same shall be indoor/outdoor/flameproof as per the location.

17.4.5 **Lighting distribution boards (LDB) & lighting panels (LP)**

Each of the LDBs shall be provided with voltmeter and ammeter along with selector switches, `Supply On' indicating lamps, etc. The LDBs and LPs shall be sheet steel enclosed and shall be fully dust and vermin proof, with a degree of protection of IP 52. Outdoor panels shall be weather proof type with IP - 54 degree of protection. The switch boxes, receptacle boxes etc., shall be made up of 18 SWG sheet steel.

17.4.6 The distribution of lighting fixtures/receptacles shall be such that the loading on each phase of the LDB is approximately equal.

17.4.7 **Wiring**

(a) 1100 V grade stranded copper conductor, PVC insulated wires to IS : 694 laid in GI conduits shall be used for lighting in non-hazardous area. In the hazardous areas cable wiring with 1100 V grade stranded aluminium conductor, PVC insulated, PVC inner sheathed, GI wire armoured and overall PVC sheathed cables to IS : 1554 shall be adopted. For outdoor areas like transformer yard, switchyard and road lighting also cable wiring as above shall be adopted.

(b) Minimum size of wires in case of conduit wiring shall be 2.5 sq.mm in case of lighting and 4 sq.mm in case of receptacle wiring. Minimum cable size in case of cable wiring shall be 4 sq.mm for lighting and 6 sqmm for receptacles.

(c) Wires of different phases shall be run in separate conduits. However wires of same phase but having different circuit nos., can be run in same conduit. Wires of lighting and power receptacles will be carried out in separate conduits and on

separate circuits. Wires of AC and DC lighting systems shall be carried out in separate conduits.

(d) For outdoor lighting, the cable shall be buried at a minimum depth of 750 mm from ground level. The buried cables shall have suitable bedding, protective covers & markers.

17.4.8 **Lighting circuit design**

(a) In an area, the lighting fixtures shall be arranged in different phases/LPs such that even in case one lighting panel goes faulty complete lighting is not affected. In case of room the lighting shall be arranged from two phases.

(b) The circuit loading on each circuit shall be restricted to 80% of the MCB rating.

(c) The voltage drop from LDB and any fixture shall not exceed 3%.

17.4.9 **Earthing**

(a) Lighting fixtures, receptacles, switches, conduits and junction boxes shall be properly earthed using 12 SWG GI wire run along the entire length of the conduit between the fixture and the corresponding lighting panel where it will be connected to the station earth.

(b) For fixtures in hazardous areas, the third core of each single-phase armoured cable circuit shall be used as earthing conductor.

(c) For outdoor earthing of lighting poles, junction boxes on the poles, 8 SWG GI wire, shall be run buried in ground at a depth of 600 mm and tapped to each lighting pole. The earth conductor shall be connected to the nearby main earthing grid at the first and last poles of each feeder circuit and at some intermediate poles.

17.5 **Tests**

Type tests, acceptance tests & routine tests for the lighting fixtures and accessories covered in this specification shall be carried out as per the relevant standards listed under "Codes and Standards" given below for the respective fixtures/ components.

DATA SHEET A3.17

1.0 APPLICABLE STANDARDS

1.1	Electric Lighting Fittings General and Safety Requirements	IS:1913
1.2	Code OF Practice for Industrial Lighting	IS:6665
1.3	Calculation of Co-efficient of Utilisation	IS:3646 (Part-III)
1.4	Industrial Lighting Fittings with Metal Reflectors	IS:1777
1.5	Decorative Lighting Outfits	IS:5077
1.6	Dust Proof Electric Lighting Fittings	IS:4012
1.7	Dust Tight Electric Lighting Fittings	IS:4013
1.8	Electric Lighting Fittings for Division 2 Areas as per IS:5572 (P1)	IS:8224
1.9	Flame Proof Lighting Fittings	IS:4013 Part (I&II)
1.10	Flame Proof Enclosure	IS:2148
1.11	Flood Lights	IS:10322 Pt-V SECT-5
1.12	Luminaires for Street Lighting	IS:10322 Pt-V SECT-3
1.13	Waterproof Electric Lighting Fittings	IS:3528
1.14	Watertight Electric Lighting Fittings	IS:3553
1.15	Bayonet Lamp Holders	IS:1258
1.16	Edison Screw Lamp Holders	IS:10276
1.17	Bi-Pin Lamp Holders for Tubular Fluorescent Lamps	IS:3323

1.18	Starters for Fluorescent Lamp	IS:2215
1.19	Holders for Starters for Tubular Fluorescent Lamps	IS:3324
1.20	Ballast for Use in Fluorescent Lighting Fittings	IS:1534 (Part 1)
1.21	Transistorised Ballast for Fluorescent Lamps	IS:7027
1.22	Ballast for HP Mercury Vapour Lamp	IS:6616
1.23	Capacitors for Use in Fluorescent, HPMV & LP Sodium Vapour Discharge Lamp Circuits	IS:1569
1.24	Vitreous Enamel Reflector for Tungsten Filament Lamp	IS:8017
1.25	Tubular Fluorescent Lamps	IS:2418 (Part 1)
1.26	High Pressure Mercury Vapour Lamps	IS:9900
1.27	Tungsten Filament General Electric Lamps	IS:418
1.28	Cast Acrylic Sheets for Use in Luminaires	IS:7569
1.29	Screwless Terminal and Electrical Connections for Lighting Fittings	IS:10322 Pt-III
1.30	High Pressure Sodium Vapour Lamps	IS:9974
1.31	Emergency Lighting Units	IS:9583
1.32	Ignition Proof Enclosures, Dust-Tight for Electrical Equipment	IS:11005
1.33	Luminaires (Part 1 to V)	IS:10322
1.34	Arrangement for Busbars, Main Connections and Auxiliary Wiring and Marking	IS 5578 IS 11353
1.35	Enclosed Distribution Fuse Boards and Cutouts for Voltages not exceeding 1000 V	IS 2675
1.36	General Requirements for Switchgear and Control gear for Voltages not exceeding 1000V	IS 4237

1.37	Code of Practice – Installation and Maintenance of Switchgear	IS 10118
1.38	Factory Built Assemblies of Switchgear and Controlgear for Voltages upto and including 1000 V AC and 1200 V DC	IS 8623
1.39	Degree of Protection of enclosed equipment for Low Voltage Switchgear and Controlgear	IS 13947
1.40	Switches, Disconnectors, Switch Disconnectors and Fuse Combination Units for Low Voltage Switchgear and Controlgear	IS 13947 Part-3
1.41	Miniature Air Break Circuit Breakers for AC Circuits	IS 8828
1.42	HRC Cartridge Fuse Links upto 650 V	IS 9224
1.43	Current Transformers	IS 2705
1.44	Voltage Transformers	IS 3156
1.45	Direct Acting Electrical Indicating Instruments	IS 1248
1.46	AC Electricity Meters	IS 722
1.47	Electrical Relays for Power System Protection	IS 3231
1.48	Flameproof Enclosures of Electrical Apparatus	IS 2148
1.49	Guide for Selection of Electrical Equipment for Hazardous Areas	IS 5571
1.50	Switches for Domestic and Similar Purposes	IS 3854
1.51	Three-Pin Plugs and Socket Outlets	IS 1293
1.52	Fans and Regulators, Ceiling Type, Electric	IS 374
1.53	Rigid Steel Conduits for Electrical Wiring	IS 9537
1.54	Accessories for Rigid Steel Conduits for Electrical Wiring	IS 3837
1.55	Flexible Steel Conduits for Electrical Wiring	IS 3480

1.56	Rigid Non-Metallic Conduits for Electrical Installations	IS 9537 Part-2
1.57	Fittings for Rigid Non-Metallic Conduits	IS 3419 Part-2
1.58	PVC Insulated Cables for Working Voltages upto and including 1100 V	IS 694
1.59	Tubular Steel Poles	IS 2713
1.60	Wrought Aluminium and Aluminium Alloys, Bars, Rods, Tubes and Sections for Electrical Purposes	IS 5082
1.61	Code of Practice for Phosphating Iron and Steel	IS 6005
1.62	Fittings for Rigid Steel Conduits for Electrical Wiring	IS 2667
1.63	Prestressed Concrete Circular Spun Poles for Overhead Power, Traction and Telecommunication Lines	IS 13158
1.64	Methods of Test for Concrete Poles for Overhead Power and Telecommunication Lines	IS 2905

18.0 EARTHING SYSTEM

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

18.1 DESIGN CRITERIA

18.1.1 Fault Current & Duration

The earthing conductor shall be designed for 40 kA for a duration of 1 second.

18.1.2 Conductor Material

The earthing system conductors and accessories as proposed are to be as follows :

(a)	Conductors above ground level and in trenches	:	Galvanised steel
(b)	Conductors buried in ground or embedded in concrete	:	Mild Steel
(c)	Electrodes	:	GS Pipe / Rod
(d)	Lightning protection air termination and down conductors for buildings	:	GS Flat
(e)	Exposed lightning protection air termination on chimney top	:	Lead coated copper

The Bidder shall undertake the soil resistivity measurements at site and select suitable type of conductors.

18.1.3 Size of Conductors

(a) **Main Earthing Conductors**

The earthing conductor sizes shall be calculated IS 3043 and shall comply with Indian Electricity rules and IEEE-80.

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
		SHEET 1 OF 9	SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
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 & 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	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-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	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
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	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
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
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
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**
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	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	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	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.
		2.ELECT. PROP, & MECH. PROP	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	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 4 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-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-	-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 :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
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**
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-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ 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**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 7 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	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	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	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	

BHEL	PARTICULARS	BIDDER/VENDOR	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 8 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	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-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	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-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (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$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS 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	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
	BHEL		**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
	SHEET 1 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 P	AGENCY W	AGENCY V	REMARKS
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		
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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-999-558-E001, REV.0	SPECIFICATION TITLE :
	SHEET 2 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 P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		6. TYPE TEST	MA	ELECT	1/RATING	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	TEST REPORT	3/2	-	1**	**** Refer note 3 & 4**
3.0	LIGHTING TRANSFORMER	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	-	
		2. TYPE TEST	MA	TEST	1/RATING	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	TEST REPORT	3/2	-	1**	**** Refer note 3 & 4**
4.0	CONDUITS	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	-	FOR SAME MANUFACTURER, 1st LOT WILL BE WITNESSED BY BHEL, SUBSEQUENT LOT CAN BE CLEARED BASED ON TEST WITNESSED BY MAIN VENDOR.
		c) BEND	CR	TEST	BHEL APPPD DATASHEET/ IS 9537	APPPD DATASHEET/ IS 9537	APPPD 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	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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-999-558-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	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		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	-	
		c) COATING THICKNESS	CR	TEST	IS 9537-II	IS-9537/ APPD DATASHEET	IS-9537/ APPD DATASHEET	INSPT. REPORT	3	2,1	-	BY ELCOMETER
		d) EPOXY THICKNESS	MA	VISUAL/PHYSICAL	IS 9537-II	50 MICRONS	50 MICRONS	INSPT. REPORT	3	2,1	-	
5.0	ELECTRIC POLES											
5.1	MATERIAL	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	
		2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2,1	
5.2	FINAL INSPECTION	1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	IS 2713	APPD DRG./ IS:2713	APPD DRG./ IS:2713	-DO-	3/2	2,1	-	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL
		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**	**BIDDER/VENDOR**	
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	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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-999-558-E001, REV.0			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 P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
6.0	HIGH MAST											
6.1	High Mast Shaft	a) Dimensional conformity	MA	MEASURE	10% or Min. 2 Nos.	APPD DRG.	APPD DRG.	TEST CERTIFICATE	3	2,1	-	
		b) Galvanising	MA	MEASURE	-do-	DATASHEET	DATASHEET	-do-	3	2,1	-	BY ELCOMETER
6.2	Head Frame	a) Dimensional conformity	MA	MEASURE	-do-	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-do-	3	2,1		
6.3	Lantern Carriage	a) Dimensional conformity	MA	MEASURE	-do-	-do-	-do-	-do-	3	2,1	-	
		b) Galvanising	MA	MEASURE	-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	MA	MEASUREMENT	100%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	INSP. REPORT	3	-	2	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/MEAS.	10%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-DO-	3	-	2	
		3.HV/IR/HV	MA	ELECT.TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	-DO-	3	-	2	
		4.DEGREE OF PROTECTION	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		5.SPECIAL TESTS IF ANY,EXPLOSION PROOF/FLAME PROOF	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		6. OPERATION CHECK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	
		7. MECHANICAL INTERLOCK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	SIGNATURE		
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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-999-558-E001, REV.0	SPECIFICATION TITLE :	
	SHEET 5 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 P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
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 & FLATS, 24V SUPPLY MODULE, LADDERS, HUME 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		BIDDER'S/VENDORS COMPANY SEAL

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 OF2		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	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
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/JINDA ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 808/ IS - 1852	IS - 808/ IS - 1852	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS:2062	IS:2062	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	CUTTING	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	
		3.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	-	-	
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		BIDDER'S/VENDORS COMPANY SEAL

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 2 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	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		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	-	-	
3.0	**FINISHED ITEMS**											
		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.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	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	IS-2633	INSP. REPORT	2	1	-	
		5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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-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 P	AGENCY W	AGENCY V	REMARKS	
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 TC'S	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/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		
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	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.	
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	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		BIDDER'S/VENDORS COMPANY SEAL

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-E005, REV. 0			SPECIFICATION TITLE:			
	SHEET 2 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 P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	2/3	-	-	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.
		2.DROSS	MA	VISUAL	PERIODIC	IS 2629	IS 2629	QC RECORD	2/3	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	IS 2629/ MFR'S PRACTICE	IS2629/ MFR'S PRACTICE	QC RECORD	2/3	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS 2629	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	QC RECORD	2/3	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSORIES & HARDWARES)	1.DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DRG	INSP.REPORT	2	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.
		2,SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP.REPORT	2	1	-	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)	MA	DEFLECTION TEST	2 No./ LOT/TYPE	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	600MM wide cable tray to be testsed. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745/ APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP.REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP.REPORT	2	1	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

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-999-509-E001, REV. 0	SPECIFICATION TITLE:
	SHEET 1 OF 2	SYSTEM EARTHING	ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	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	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

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-999-509-E001 REV. 0					SPECIFICATION TITLE:				
	SHEET 2 OF 2	SYSTEM EARTHING	ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS					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
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.
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS 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	-	-	
3.0	**FINISHED ITEMS**	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-	1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab
		2.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1 LEVEL S-4	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	INSP. REPORT	2	1	-	
		3.SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1 LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	TITLE MOTOR DATA SHEET – C 4 X 270 MW BHADRADRI TPS	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			

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 ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

ANNEXURE-II

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

	LOAD DATA (ELECTRICAL)	JOB NO.	409	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	1X370MW YELAHANKA TPS	NAME		DATA FILLED UP ON
		SYSTEM	IDCT	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION	MSE	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

CABLE SCHEDULE FORMAT **ANNEXURE III**

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH