2 X 660 MW CSPGCL HTPS KORBA WEST TPP

TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER (NDCT)

BOOK 1 OF 2

(MECHANICAL, ELECTRICAL AND C&I SPECIFICATION)

SPECIFICATION No. **PE-TS-530-165-W001**
REV NO. 01

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

INDEX

PROJECT INFORMATION

SL.NO	DESCRIPTION	DETAILS
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1.2	MINIMUM TEMPERATURE	
1.3	MAXIMUM RELATIVE HUMIDITY	
1.4	MINIMUM RELATIVE HUMIDITY	
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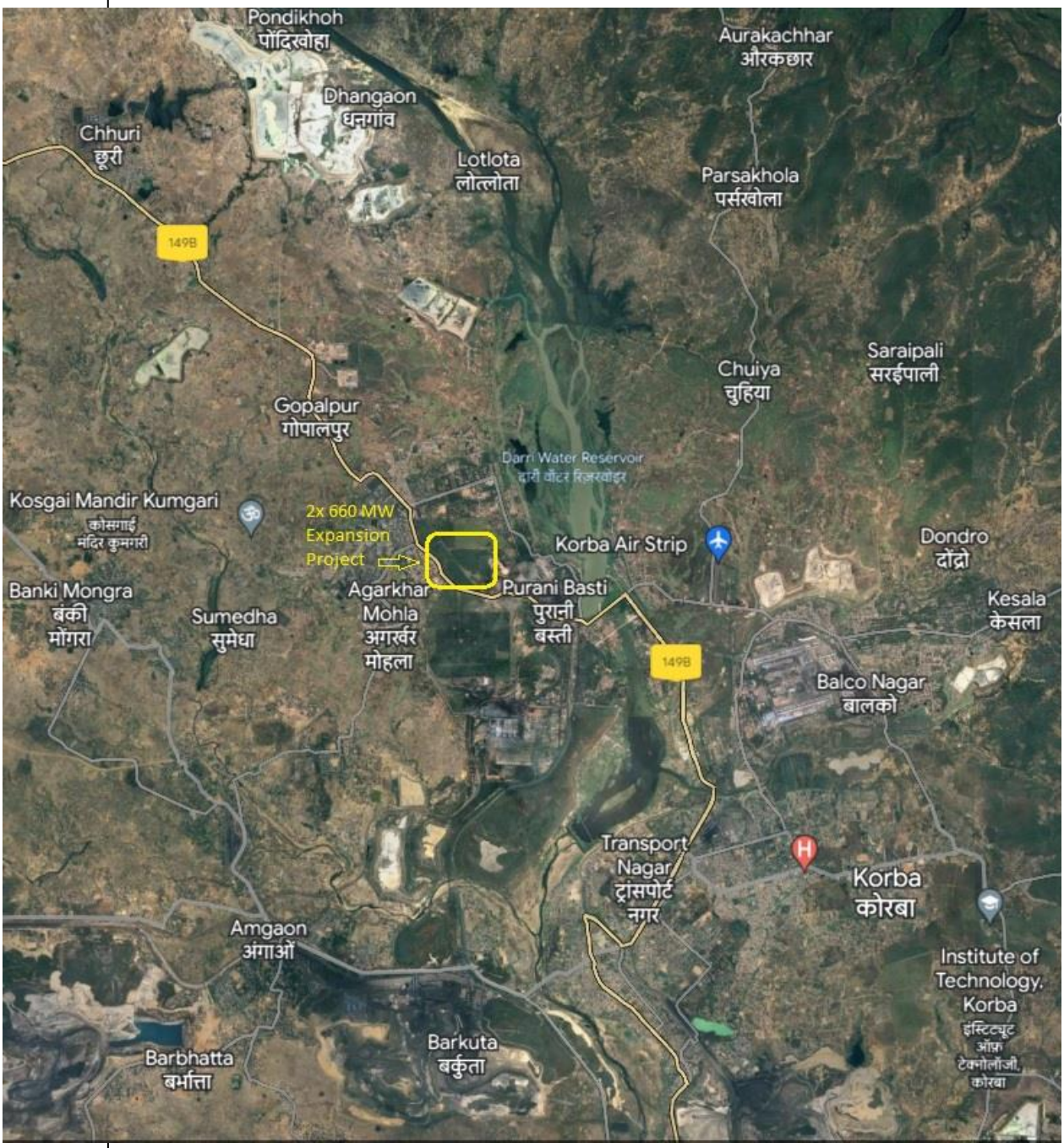
2	**ELECTRICAL DATA**	
2.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL EQUIPMENT	50 deg C
2.2	RATED FREQUENCY	50 Hz
2.3	FREQUENCY VARIATION	(+)3% to (-)5%
2.4	AC VOLTAGE	415V, 3 Phase
2.5	AC VOLTAGE VARIATION	+/-10%
2.6	DC VOLTAGE	220V
2.7	DC VOLTAGE VARIATION	(+)10% to (-)15%
2.8	FAULT LEVEL (KA/SEC)	50 at rated voltage
3	**SITE LOCATION:**	
3.1	Chhattisgarh State Power Generation Company Limited (CSPGCL), a Govt. of Chhattisgarh Undertaking, commissioned 4x210 MW & 1x500 MW Hasdeo Thermal Power Plant together with all other infrastructures at Korba village in Korba district of Chhattisgarh in three stages i.e., Stage-I, Stage-II & Stage-III respectively using coal from Kusmunda, Junadih coal mine blocks of Coal India's South-eastern Coal Field Limited (SECL). The Present proposal is for setting up of two (2) units of 660 MW capacity each as an extension of the existing Power Plant within the available land inside the premises of existing Plant and surrounding area.	
3.2	The Hasdeo Thermal Power Station project is located at Korba Village in Korba District of Chhattisgarh. Access to the Project Site by Road is through State Highway No. 39 from Raipur and Bilaspur. The Site is located at latitudes of 22°24'38.5" N and longitudes of 82°41'39" E, respectively. Other Major Towns / City nearer to the Project site are Korba at about 10 Kms, Champa at about 45 Kms and Bilaspur at about 125 Kms.	
3.3	Nearest railway station is Korba railway station, located on Gevra Road – Champa section under Bilaspur railway division of South-East Central Railway zone. The nearest commercial airport is Swami Vivekanand Airport, Raipur which is at a distance of 214 Kms from the Project site.	
4	**GRADE LEVEL:** For NDCT Area, Finished Graded Level (FGL) shall be R.L. (+) 306M above mean sea level:	
5	**SOIL CONDITION AND GROUND WATER LEVEL & HFL**: Type of foundation, depth, safe bearing capacity, ground water table etc., shall be as per the Geotechnical Investigation report.	
6	**SEISMIC:** Refer CIVIL SPECIFICATION Book 2 of 2.	
7	**WIND PRESSURE:** Refer CIVIL SPECIFICATION Book 2 of 2.	

Annexure-I

VICINITY MAP



Annexure-II

CLIMATOLOGICAL DATA STATION: IMD - AMBIKAPUR

Month	Atmospheric Pressure (mb)		Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
	0830	1730	Max	Min	Mean Max	Mean Min	
January	947.9	945.1	27.6	4.8	77	50	25.8
February	946.3	943.5	31.5	7.2	67	40	20.1
March	944.5	941	37	11.5	51	29	19.5
April	941.8	937.9	41.1	16.6	39	23	13.6
May	938.1	934.3	42.8	20.6	43	28	21.3
June	934.7	931.8	41.9	21.4	66	55	235
July	934.6	932.4	34	21.4	86	81	411.2
August	935.5	933.2	32.4	21.5	88	83	352.2
September	939	936.4	32.5	20	86	79	227
October	944.2	941.5	31.9	13.4	79	64	48.4
November	947.2	944.5	29.1	8.7	77	57	14
December	948.5	945.6	26.4	5.5	77	54	11.2
						Total	**1399.3**

Source: Climatological Norms 1981-2010

NORMALS AND EXTREMES OF RAINFALL
KORBA

STATION	No. of Years of Data		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	ANNUAL RAINFALL AS % OF NORMAL & YEARS**		HEAVIEST RAINFALL IN 24 HOURS*	
																HIGHEST	LOWEST	AMOUNT (mm)	DATE
Kartala	10	a	7.4	8.0	7.9	3.2	1.1	160.9	450.2	383.8	224.9	63.1	8.9	2.3	1321.7	134	82	207.5	30 Jun 2005
		b	0.4	0.7	0.8	0.4	0.1	6.8	18.0	15.6	10.6	2.9	0.4	0.3	57.0	(2003)	(2006)		
Kathgora	48	a	13.9	13.2	10.5	6.7	11.4	201.5	448.3	429.7	228.1	46.6	10.8	5.6	1426.3	200	54	433.6	24 Nov 1958
		b	1.0	1.0	0.9	0.7	0.8	8.2	18.0	16.8	11.1	2.3	0.5	0.3	61.6	(1961)	(1979)		
Korba	23	a	20.1	12.8	5.6	29.0	7.6	206.1	492.3	472.7	237.4	56.4	12.5	10.6	1563.1	205	67	358.0	12 Aug 2004
		b	0.6	0.9	0.3	0.1	0.4	8.5	17.2	15.7	10.1	3.1	0.7	0.6	58.2	(1988)	(1993)		
Kotaghat	27	a	13.6	19.6	12.2	12.5	6.9	182.3	344.1	396.1	175.1	37.5	6.6	12.5	1219.0	154	50	224.0	01 Aug 1969
		b	1.2	2.0	1.1	1.1	0.6	8.4	16.4	17.0	9.7	2.5`	0.4	0.5	60.9	(1961)	(1965)		
Pali	11	a	12.8	6.2	3.0	2.3	5.4	144.1	413.4	347.1	257.0	46.8	1.7	0.0	1239.8	140	83	195.0	06 Aug 2005
		b	0.5	0.6	0.3	0.3	0.7	7.4	15.4	13.4	9.9	2.1	0.2	0.0	50.8	(2001)	(2009)		
Korba (District)		a	13.6	12.0	7.8	10.7	6.5	179.0	429.7	405.9	224.5	50.1	8.1	6.2	1354.1	236	56		
		b	0.7	1.0	0.7	0.5	0.5	7.9	17.0	15.7	10.3	2.6	0.4	0.3	57.6	(1988)	(1979)		

a: Normal rainfall in mm.
b: Average number of rainy days (i.e. days with rainfall of 2.5 mm or more)
* Based on all available data.
** Years of occurrence given in brackets.

Frequency of Annual Rainfall in the District KORBA (Data 1961-2010)

Range in mm	No. of years	Range in mm	No. of years
701 – 800	1	2001 – 2100	0
801 – 900	0	2101 – 2200	1
901 – 1000	2	2201 – 2300	0
1001 -1100	2	2301 – 2400	1
1101-1200	6	2401 – 2500	0
1201-1300	6	2501 – 2600	0
1301-1400	4	2601 – 2700	0
1401–1500	5	2701 – 2800	0
1501-1600	4	2801 – 2900	0
1601-1700	2	2901 – 3000	0
1701-1800	2	3001 - 3100	0
1801-1900	1	3101 – 3200	1
1901-2000	1		

(Data available for 39 years)

Source : IMD CLIMATOLOGICAL SUMMARIES OF STATES series 22

	GENERAL TECHNICAL REQUIREMENT
1	The design, manufacture, inspection & testing and performance of Cooling Tower complete with all accessories, shall generally conform to the latest editions of the appropriate standards.
2	The equipment shall comply with all applicable safety codes and statutory regulations of India where the equipment is to be installed.
3	Latest codes and standards shall be applicable as on date of bid submission
4	In the event of any conflict between the requirements of two clauses of this specification, documents or requirements of different codes and standards specified, stringent requirement as per the interpretation of the BHEL / owner shall apply.
5	Bidder to note that drawing/document submission shall be through web based Document Management System. Bidder will be provided access to the DMS along with adequate training for drg/doc approval. Bidder to ensure proper net connectivity at their end.
6	The first submission/ revised submission of drawings/ documents by vendor shall be complete in all respects. Incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/ discussion required to complete the drawings, the bidder shall depute his personal to BHEL / Customer's place as per the requirement for across the table submissions/ discussions/ finalizations of drawings.
7	Drawing / documents to be submitted by bidder shall be as per "Documentation Requirement" given in this specification.
8	The scope of supply/ works for complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements as per TECHNICAL DATA - PART - A.
9	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.
10	The omission of specific reference to any component / accessory which is necessary for completion of the system and for the proper performance of the equipment / Cooling Tower shall not relieve the bidder of the responsibility of providing such facilities to complete the supply / erection / commissioning etc. of Cooling Tower at quoted prices. In case this is not clear to bidder, the bidder may seek clarifications to same, failing which the specification intent shall be binding on bidder.
11	**Cement and reinforcement steel for Cooling Towers are excluded from Bidder's scope and shall be free issue as per NIT. Terms and Conditions for free issue items being given along with NIT.**
12	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.
13	The materials of construction for various components specified are the minimum requirements. Superior materials suitable for fluid handled is also acceptable subject to Customer/BHEL approval. Materials of construction for other components not specified shall be similarly selected by the bidder for the intended duty and subject to Customer/BHEL approval.
14	Cost of Piling (if any) shall be included by bidder's in their quoted price.

15	The location, orientation, wind rose, scope demarcation etc. for the cooling tower shall be as per the sketch enclosed in 'Compliance drgs' as Annexure-III.
16	Size of Isolation Valves shall be same as that of pipe size.
17	Minimum pipe thickness for overground piping shall be as follows: • 5.4 mm for pipe size upto 150 NB • 6.0 mm for pipe size from 200 NB and upto 600 NB • 7.0 mm for Pipe size 700 NB • 8.0 mm for pipe size 800 NB.. • 10 mm for Pipe size 900 NB to 1100 NB. • 12 mm for pipe size 1200 NB. • 12.5 mm for pipe size for 1400 NB. • 14.2 mm for pipe sizes from 1600NB upto 1800NB • 16 mm for pipe size for 2000 NB. • 18 mm for pipe size for 2200 NB. • 20 mm for pipe size from 2500 NB upto 2800 NB. All pipes shall be adequately supported.
18	Burried CW pipe in Bidder's scope shall be concrete encased. The concrete encasement shall be of minimum 500mm thick with square shape outside. Generally, M20 grade PCC encasement shall be provided. At locations of duct crossing road, rail in transformer yard or any other facility, RCC encasement of grade M25 shall be provided. Minimum two layers of reinforcement (On both faces) of 12 mm diameter bars @ 200 mm c/c shall be provided for RCC encasement of CW Pipe. Top of CW pipe encasement shall be minimum 1.5 m below finished ground level.
19	The minimum thickness of concrete encased below ground steel pipes shall be as follows including corrosion tolerance of 2 mm: • Upto 1800 mm dia. - As per thickness of above ground piping indicated above. • For pipes above 1800 mm upto and including 2300 mm dia. - 12 mm • For pipes above 2300 mm upto and including 3200 mm dia. - 14 mm • For pipes above 3200 mm upto and including 3750 mm dia. - 16 mm • For pipes above 3750 mm upto and including 4000 mm dia. - 20 mm However, for concrete encased steel pipes running below road, minimum thickness of CW pipe shall be 20 mm.
20	Following shall be considered for design of C.W. concrete encased CW Pipes: (a) Maximum design water pressure (b) Surge or water hammer pressure of 5.0 Kg / Sq.cm. (c) Vacuum of 0.1 kg/cm² (abs). (d) Soil overburden (e) Surcharge Pressure of 2T/Sq.m (f) The effect of concrete encasement shall not be considered in the design of CW duct.
21	The completed CW pipe shall be tested for water tightness, for the pressure equal to twice the working pressure or 1.5 times the design pressure whichever is higher and shall be generally water tight to BHEL/End Customer's satisfaction. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld. Any in flow / leakage of water from the duct shall be sealed / repaired at Contractor's cost. However, tests in part of length of duct may be permitted with prior approval only.
22	Manholes of minimum 1000mm clear opening shall be provided in each CW pipe to facilitate maintenance of Butterfly valve / dewatering of CW pipes. At least one manhole shall be provided at the deepest point.

23	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.
24	The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Technical Data Part-A.
25	Special tools & tackles, if any, shall be included in scope of supply by the bidder. A list giving description of such tools & tackles shall be furnished by vendor.
26	All the components shall be capable of safe, proper and continuous operation at all cooling water flows upto and including those specified under Technical Data Part-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.
27	CT basin shall be provided with adequate slope (Min slope of 1:120) towards the sludge sump for drainage purpose.
28	The spares provided shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during handling/storage at site till the time of erection/usage.
29	The quality of water in CW sump shall be clarified water with analysis as given in Technical Data Part-A. Chlorination to control biological/ algae growth is envisaged in purchaser's scope.
30	No wood/ timberwork shall be used in any component of the cooling tower.
31	All parts subjected to periodical maintenance & inspection such as Inlet louvers (if applicable), fills, drift eliminators etc. shall be readily accessible.
32	Access doors shall be provided for entry into cooling water distribution level. The doors shall be easily operable with leak proof design.
33	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.
34	It is mandatory for the bidder to submit along with the bid, the deviations if any – whether major or minor in the schedule of deviations only. In the absence of deviations listed in the "Schedule of deviations, the offer shall be deemed to be full conformity with the specification, "not-withstanding" anything else stated elsewhere in bidder's offer. The implied/ indirect deviations shall not be binding on the purchaser.
35	For review/approval of drawings, bidder shall depute its concerned personnel for across the table finalization of drgs/docs at Engineer/owner's office, as and when required. No price shall be admissible to bidder for same and bidder's offer shall be considered inclusive of the same.
36	Bidder may note the thermal calculations must be enclosed with the offer. In case these calculations are based on the collaborator's design then these calculations should be duly vetted by his collaborator. The bidder shall show, explain and prove the validity of the basis, procedures and methods used in these calculations.
37	Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.

38	The Contractor shall guarantee the long term availability of spares to End Customer for the full life of the equipment covered under the contract. The Contractor shall guarantee that before going out of production of spares parts of the equipment covered under the Contract, he shall give the Employer atleast 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub contractors, Contractor will provide the Employers, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/ procurement of such items.
40	**CONTROL AND INSTRUMENTATION:**
40.1	Complete Field Intrumentation for monitoring and operation of NDCT package be provided by bidder.
40.2	The quantity of instruments for the system indicated in "General Technical Requirement" shall be considered as minimum requirement by the bidder. Any other instrument/item required for completeness of the system shall be in bidder's scope of supply.
40.3	Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers ((from BHEL/customer approved vendor list) of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance and shall comply with the acceptable international standards.
40.4	Following items are to be supplied by Bidder as a minimum for PG Test: Temperature Elements(RTD-Two number) with necessary stub, fitting, mounting arrangements for each of the Hot Water Riser in canopy. Temperature Elements(RTD-Nine number) with necessary stub, fitting, mounting arrangements etc. in the cold water channel for each cooling tower in canopy. Pitot Tube for flow mesurement along with manometers and stub connections along with Isolation (Gate valve) Valves for each unit, in purchaser's scope of CW Piping. Anemometer (one number) for measurement of wind velocity. Psychrometer - Mechanically aspirated installed with RTD (Sixteen number). Barometer (one number) for measurement of atmospheric pressure. A temporary test Data Acquisition System (DAS) shall be used to monitor the majority of the precision test pressures and temperatures. The test DAS will include at least one (1) data logger connected to a laptop computer. Automatically monitored parameters will be scanned a minimum of once every 30 seconds using the test DAS. If the data acquisition system is not available for testing, primary measurements will be manually recorded every five (5) minutes. The requirements given here are to be read in conjunction with "CT PG test procedure" attached elsewhere in the Technical specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification,the more stringent requirement as per interpretation of customer shall prevail without any commercial implication. Additionally, 1 No. PG & 1 No. TG to be provided at each Hot Water Riser.
40.5	Root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold, junction box and all other accessories required for mounting/erection of local / remote instruments shall be provided by bidder.

40.6	The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes.
40.7	Number of pairs to be selected for Screen /Control cable 1. F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2) 2. G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
41	**3D MODEL REQUIREMENT:**
41.1	Bidder shall submit 3D Parametric model of the cooling tower area within terminal points compatible with E3D library.
41.2	Bidder to preferably use default library of E3D for creation to primitives/ model /layout so that it can be integrated with 3d model of the main plant
41.3	FOLLOWING REQUIREMENTS TO BE MET BY BIDDER
41.3.1	All the layouts shall be made using computerized 3D modelling system (E3D). The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check
41.3.2	Contractor shall prepare 3D design review model (network ready, which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc), which is extracted from intelligent 3D model, for employer's review as & when desired by the employer.
41.3.3	The complete editable 3D model (complete 3D data) along with complete component catalogues for all the size range, configuration files, customization files, templates and all referenced databases pertaining to 3D model of the package etc. with any other document generated from 3D model and naming conventions with as-built updates shall be handed over to the employer after completion of Engineering.
41.3.4	The corresponding complete 3D review model shall also be handed over to the employer for reference after the completion of engineering of respective package.
41.4	**Handover Plan:** There shall be continuous handover of documents and data at various stages of the project including rules and trigger points for handover of data to employer shall be at 30%, 60% and 90 % of 3D model stage.
42	**BID EVALUATION CRITERIA:**
42.1	The bids shall be evaluated based on the Cooling Tower prices quoted by the bidder and quantity of Cement and reinforcement steel used in Cooling Tower.
42.2	Bidder shall furnish the quantity of Cement and reinforcement steel in the Price offer. The evaluation rate for Cement and reinforcement steel shall be as per the rates given in the Price Schedule/NIT.
42.3	During civil design while furnishing the drawing/ design for BHEL’s review / approval, bidder shall also furnish the design quantities of Cement and reinforcement steel in the drawings.
42.4	If the total quantity of Cement and reinforcement steel during contract execution is found to be more than the quantities quoted at tender stage, the additional cost for excess quantity of Cement and Reinforcement steel shall be deducted from the bidder’s payments as per the rates and other terms & conditions specified in the NIT.

TECHNICAL DATA - PART - A (MECHANICAL)

This enquiry covers the complete cooling tower 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, performance guarantee testing of Natural draft cooling tower (NDCT) including electrical, C&I, Civil & Structural works, as specified & as necessary for completeness in all respects and for efficient & trouble free operation along with mandatory spares (as applicable).

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.

SL.NO	DESCRIPTION	DETAIL
1.0	**Scope of supply**	
1.1	Acceptance Test Code for Industrial Water Cooling tower.	Cooling Tower Institution of USA, Bulletin ATP-105
1.2	Performance Test Code for Atmospheric Water Cooling equipment.	PTC-23:ASME
1.3	Specification for Water Cooling Towers.	BS-4485.
1.4	Thermo-Hydraulic Design of Natural Draught Counter Flow Cooling Towers — Guidelines	IS 18705 : 2024
2.0	**Scope of supply**	
2.1	All Cooling Tower related Civil works including Shell, Superstructure, substructure, foundation, grillage work, basin, outlet channels/ sump, sludge pits etc with details as per specification.	Yes, within terminal points
2.2	Cement	No (free issue by BHEL)
2.3	Reinforced Steel	No (free issue by BHEL)
2.4	Fills	Yes
2.5	Drift Eliminators	Yes
2.6	Hot water piping to distribution duct	Yes, within terminal points
2.7	Encasement of buried hot water duct	Yes, within terminal points
2.8	Hot water header isolation valves on risers	No (Motorized BFV shall be supplied by BHEL), however its Erection is in Bidder's scope
2.9	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	Yes
2.10	Screen & guide for each cold water outlet sump/ channel	Yes
2.11	Stop log gate with guides and sealing device for each cold water outlet sump/ channel	Yes
2.12	Isolation valves in sludge pit	Yes
2.13	Submersible Type sludge pumps (Auto-Coupling type) along with valve (Isolation Valve & NRV) and other accessories	Yes

2.14	Drain Piping from sludge pump to terminal point	Yes, upto terminal point. Further, Piping upto PT Plant Clarifier Sludge Sump (at distance of approx. 1000 M beyond sludge pipe terminal point) shall be provided by BHEL.
2.15	Handling arrangement with monorail and a chain operated hoist with a travelling trolley and chain pulley blocks for handling of sludge pumps (Minimum 1 Ton)	Yes
2.16	Handling arrangement with monorail and a chain operated hoist with a travelling trolley and chain pulley blocks for lifting each screen & Gate in cold water outlet sump/ channel	Yes (Min. 2 nos.)
2.17	All necessary supports, hangers and anchors	Yes
2.18	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipments supplied	Yes
2.19	Cross over facility, as required, over hot water pipes (applicable as per layout requirement)	Yes
2.20	Paving all around cooling tower periphery	Yes
2.21	Flushing lines with davit type valves in each branch at the end of hot water distribution pipes to enable removal of debris from the system at the start of commissioning.	Yes
2.22	Electrical and C&I	Yes as per respective specification
2.23	*Licensed & latest version of CTI Tool Kit software to verify the Cooling Tower Demand/Design*	*Yes*
2.24	Mandatory spares	Yes
2.25	Special tools & tackles required for maintenance of equipment & accessories	Yes
2.26	Various drawings, datasheets, calculation, test reports/ certificates, operation & maintenance manuals including “As built drawings” etc. as specified & as necessary.	Yes
2.27	Supply of first fill of lubricants for all equipment under this package including second fill/ replenishment as necessary after commissioning & handing over of the plant.	Yes
2.28	Supply of commissioning spares on as required basis.	Yes
2.29	Any additional system/ equipment required to make the system complete.	Yes
3.0	**Scope of Services**	
3.1	Transportation, delivery, unloading / handling at site and storage at Site	Yes
3.2	Civil & structural works (including piling if any) at site	Yes

3.3	Erection & Commissioning at site	Yes
3.4	Performance Gaurantee at site	Yes
3.5	Wind tunnel study	Yes
3.6	Any other service required to make the system complete.	Yes
4.0	**Terminal Point**	
4.1	a) Hot Water Supply Header Terminal point location: b) Hot water Pipe size in Purchaser scope at T.P: c) Centre line of Hot water Header pipe at T.P: d) Further scope of Hot water individual risers upto & including Hot water Duct in NDCT: e) Isolation BFV's in Individual Hot water riser pipe:	a) Refer Annex-III.(Approx. 85m away from NDCT center) b) 3640mm X 16 mm thk. c) Refer Annex-III d) Bidder's scope. e) BHEL scope
4.2	a) Cold Water Outlet Channel Terminal point location: b) Cold Water Outlet Channel size in Purchaser scope at T.P:	a) Refer Annex-II.(85m away from NDCT center) b) Refer Annex-II
4.3	Sludge Pumps discharge pipes	Approx. 100 M distance from NDCT#1 Sludge pit. (Apprx. Coordinates 530 N, 500 W) for both NDCTs
4.4	Electrical	Refer Electrical scope sheet
5.0	**CONSTRUCTION FEATURES FOR EACH COOLING TOWER**	
5.1	Whether fills are easily installable & removable	Yes
5.2	Fills supported by nailing acceptable	No
5.3	Number of stair cases from ground level up to hot water distribution system for maintenance inside the Cooling tower	Two(2) nos. viz. one at each end.
5.4	Number of cage ladders a) Upto top platform of Shell: b) Upto intermideate level platform of Aviation light installation:	Minimum Four (4) Nos. a) Minimum two (02) Nos b) Minimum two (02) Nos
5.5	Internal walkway of platform with hand rails	Refer Book 2 of 2 (End customer's civil specification)
5.6	External walkway platform	Refer Book 2 of 2 (End customer's civil specification)
5.7	Platform for access and operation of BFV	To be Provided by Bidder
6.0	**Material of construction**	
6.1	Cold water basin, outlet channel/ sump & sludge pit.	R.C.C.
6.2	Shell & Superstructure	R.C.C
6.3	Basin partition walls	R.C.C
6.4	Internal/External walk way & platform	R.C.C
6.5	Staircase	R.C.C / FRP

6.6	Access Ladder	Heavily galvanized (610 gm/ sq.m) in accordance with IS: 2629 with corrosion resistant protective coating Surface preparation in accordance with IS:6129.
6.7	Hand rails	Pultruded FRP
6.8	Supporting structures	R.C.C.
6.9	Hot water distribution nozzles	PVC/ Polypropylene / Gun metal as per IS:318 Gr. VI
6.10	Fills	PVC/PP/ as per Bidder's proven practice
6.11	Fill support	RCC/SS-316
6.12	Louvers	Bidder’s proven practice
6.13	Drift eliminators	PVC (UV Stablised)
6.14	Doors for access to distribution system	FRP
6.15	Fasteners/wetted parts	SS-316
6.16	a) Piping above 200 NB b) Piping 200 NB and below	a) Carbon steel plates to IS 2062 E250 Gr BR, rolled and welded as per IS 3589 b) IS 1239 (Heavy Grade)
6.17	Hot Water Distribution Pipes (Inside CT)	HDPE (IS 4984 PN 6 GRADE PE 80) / PVC (IS 4985 Class 3) / FRP (Fiber reinforced plastic) pipes or RCC/pre-cast open trough.
6.18	Sludge pit isolation valves - Body	ASTM A 216 Gr. WCB
6.19	Sludge pit isolation valves -Spindle & Trim	ASTM A 182 Gr. F6 or Equivalent
6.20	Sludge outlet pipe	CI IS-1536, LA
6.21	Stop Log gate in Cold water Outlet Basin	As specified in NTPC civil & mechanical specification
6.22	Guide for Stop Log gates	
6.23	Screen	
6.24	Guide for Screen	
6.25	Bolts, buts & other hardware	SS 316
6.26	Submesible Sludge Pumps - Casing	2.5 Ni% Ni-Ci to IS 210 Gr. FG-260
6.27	Submesible Sludge Pumps -Impeller	ASTM A351 CF8M
6.28	Submesible Sludge Pumps - Shaft/Sleeves	SS-316/SS-410
6.29	Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity	Heavily Galvanised (610gm/Sqm in accordance wth IS 2629 with corrosion resistant protective coating Surface preparation in accordance with IS:6129)
6.30	Material of construction for items not specified	As per purchaser’s approval during detailed engineering.
7.0	**INSPECTION/TESTING**	

7.1	Quality Surveillance by	Manufacturer, BHEL and Customer
7.2	Material testing and identification	Yes, as per approved QAP
7.3	Stage inspection to be witnessed by BHEL and Customer	Yes, as per approved QAP
7.4	Hydrostatic test for piping & valves required	Yes
7.5	Hydrostatic test to be witnessed by BHEL and Customer	Yes, as per approved QAP
7.6	Field performance test of individual items and the cooling tower as a whole required	Yes
7.7	Field performance test to be done by	Ref PG test chapter. In addition, PG test shall be carried out by the contractor within one year of successful completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified, preferably in the period from May to September.

SL.NO	DESCRIPTION	UOM	DETAIL
8.0	**DESIGN /SYSTEM PARAMETERS FOR EACH COOLING TOWER**		
8.1	No. of Cooling Towers required	Nos.	One (01) per unit viz. Total two (02) nos for station
8.2	Duty	-	Continuous
8.3	Type	-	Natural draught Cooling tower
8.4	Air & Water Flow pattern	-	Counter Flow
8.5	Fill Type	-	Modular splash/ Trickle grid/ Turbo splash or splash type fills like V-bar splash/splash grid
8.6	Design Cooling water flow	M3/hr	72500
8.7	Design Ambient Wet bulb temp	Deg C	27
8.8	Design Inlet wet bulb temp	Deg C	27
8.9	Design Cold water temperature	Deg C	32.5
8.10	Hot water inlet temperature	Deg C	42.32
8.11	Cooling Range	Deg C	9.82
8.12	Design Ambient Relative Humidity	%	50
8.13	$(KaV/L)_{Tower} = (KaV/L)_{Fill} + (KaV/L)_{rain\ zone}$ where, $(KaV/L)_{Fill}$ = As per Approved Fill Equation, $(KaV/L)_{rain\ zone}$ = To be considered by Bidder along with calculation for the selected value of $(KaV/L)_{rain\ zone}$ in thermal sizing which shall be subject to approval by Customer/BHEL. However, Maximum value of $(KaV/L)_{rain\ zone}$ should not exceed 20% of the $(KaV/L)_{Fill}$. KaV/L in Spray Zone is not allowed in the thermal sizing calculation of Cooling Tower.		
8.14	Liquid Handled	-	Clarified water with COC 5 (Annexure-I)
8.15	Maximum CW Pumping head permissible, viz. static head plus frictional losses as below: - Static head upto Top elevation of hot water distribution header from FGL - Frictional losses within bidder's T.P. with 10% margin	MWC	16.0
8.16	Maximum permissible Evaporation loss.	%	1.65
8.17	Maximum permissible drift loss	%	0.001
8.18	Design pressure for hot water distribution system	kg/cm2 (g)	6
8.19	Cooling tower flow capacity to be considered for design of hot water distribution, basin and cold water channel	%	120% of NDCT Design Cooling Water Flow
8.20	Finished ground level (FGL)	M	EL (+) 0.5 M (RL 306 M)

8.21	Maximum water level	M	EL (+) 0.5 M (RL 306 M)
8.22	Normal Water Level	M	EL 0.0 M (RL 305.5 M)
8.23	Min. Water level	M	EL (-) 0.5 M (RL 305 M)
8.24	Min. Free board above Maximum water level	M	0.3 M
8.25	Invert level of CT Basin	M	EL (-) 1.0 M (RL 304.5 M)
8.26	Invert level of CW channel near CT Outlet	M	EL (-) 3.0 M (RL 302.5 M)
8.27	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary provision for dewatering arrangement
8.28	Maximum Basin outside Diameter	M	130
8.29	Depth of Sludge pit	M	Suitable for complete dewatering of CT basin.
8.30	Submersible Type sludge pumps	No.	2 Nos.(1 Working + 1 Standby) of min cap 150 cub M/ Hr. Head of the Pump should be selected to discharge sludge upto Clarifier Sludge Pit.
8.31	Number of sludge pits	No.	Two (2) with isolating valves, and spool pipe
8.32	Number of cold water outlet channels	No.	Two (2) Nos. Cold water channel shall be provided i.e. one each on one part of basin. Common water outlet channel shall match with Purchaser's channel at TP (Annexure-II)
8.33	Number of screens and gates in common outlet channel/Basin each) (Minimum)	No.	One (1)
8.34	Maximum allowable effective velocity through Cold water Outlet Channel	M/sec	1.8
8.35	Maximum allowable effective velocity through gates/screens at Min. Water Level	M/sec	1.2
8.36	Maximum allowable velocity in Hot water Pipes	M/sec	2
8.37	Maximum allowable velocity in Sludge Pump discharge pipe	M/sec	2
9.0	**PERFORMANCE PARAMETERS (TO BE GUARANTEED BY BIDDER)**		
9.1	Cold-water temperature	DegC	32.5
9.2	Maximum CW Pumping head permissible (as per sl. no. 7.15 above)	MWC	16

(B) COOLING TOWERS - NATURAL DRAFT (MECHANICAL)

1.00.00 GENERAL

This specification covers the design, engineering, manufacture, shop fabrication, testing at works, transportation to site, unloading and storage at site, fabrication at site, Installation, testing and commissioning of Natural draught cooling tower for power plant cooling system. The minimum technical requirements and equipment shall include, but not be limited to the following:

2.00.00 CODES AND STANDARDS

The design, manufacture, inspection, and testing shall comply with all currently applicable standards. The equipment shall also conform to the latest applicable British/American standards. The equipment shall conform to the latest edition of the following standards: -

i) Cooling Tower Institute Publications.

ii) BS 4485-Specification for Water Cooling Towers.

3.00.00 DESIGN REQUIREMENTS / CRITERIA

3.01.00 The cooling tower shall be designed to meet the duty conditions as specified in this tender specification. Employer may get the verification and review of contractor's design done through third party (who can be employer's consultant/reputed designer/ National or International Technological Institute/National or International body on cooling tower & it's components), if required (during detailed engineering). All necessary data/ details/ drawings shall be provided by the contractor to get the same carried out.

The cooling tower shall be capable of cooling the rated capacity of water through the designed cooling tower range at the design ambient wet bulb temperature, design relative humidity and other design parameters as specified elsewhere. The design parameters shall be met with average wind velocity taken as 3.5 m/sec.

3.02.00 The cooling tower shall be designed with minimum restriction to air flow and continuous operation throughout the year.

3.03.00 The cooling tower shall be complete with shell, basin, foundations, fill, and fill supports as described subsequently.

3.04.00 The hot water distribution system, of the tower shall be designed to ensure equal distribution of heat load and flow all over the fill area.

3.05.00 The water distribution system, basin and cold-water discharge channel shall be designed in such a way that it can handle 120% of rated water flow without any overflow in basin.

3.07.00 Bidder shall ensure that the design parameters of the tower are maintained when both the cooling towers are operating simultaneously.

3.08.00 Bidder shall furnish performance characteristic curves for following variations in design parameters.

a) RH- 15%,25%,50%,60%,70%,80%,90%,100%

b) Design flow-90% to 110%.

c) Cooling range-90% to 110%.

d) Nominal ambient air wet Bulb Temperature 15°C to 30°C in steps of 1.0°C.

e) Ambient wind velocity -0 to 5 m/sec.

3.09.00 Bidder shall also clearly identify various 'Guaranteed Zones" as per the requirement of Code.

3.10.00 Contractor shall submit, performance test reports of similar towers installed by them. Such reports shall include the details of packing arrangement and must have been duly approved

by the purchaser. Contractor may note, the calculations specified above must be submitted. The contractor shall show, explain, and prove the validity of the basis, procedures and methods used in these calculations.

4.00.00 **Thermal Design Criteria**

The thermal design of cooling towers shall fulfil following design criteria.

4.01.00 Sensible heat of evaporated water shall be considered for calculating the air flow requirement, as per the following equation:

GH = L(TI-T2) + EVT2

Where

L = Water flow rate in kg/hr.
TI = Water inlet temperature to the tower in deg C.
T2 = Water outlet temperature to the tower in deg C.
EV = Evaporation loss in kg/hr at RH = 50%
G = Air flow rate in kg/hr.
H = Change in enthalpy of air in kcal/kg.

4.02.00 For the specified design conditions of water rate, range, approach, wet bulb and dry bulb temperatures Bidder shall calculate and furnish the duty coefficient `D'. A nomogram indicating the ratio of water rate and duty coefficient, recooled water temperature and other thermal conditions specified shall be furnished with the bid. The monogram shall cover the entire operating range and shall extend up to a wet bulb temperature of 30°C.

4.03.00 Based on the duty co-efficient and performance characteristics of the fill the bidder shall furnish an equation expressing the relationship between the plan area of packing and the square root of tower height.

5.00.00 **Constructional Features**

Wood/timber shall not be used as construction material in any part of the cooling tower.

SN	Description	Material
1	Hot water inlet pipes	Mild steel to IS :2062 tested quality / GRP
2	Hot water distribution system	HDPE (IS 4984 PN 6 GRADE PE 80) / PVC (IS 4985 Class 3) / FRP (Fiber reinforced plastic) pipes or RCC/pre-cast open trough.
3	Cooling tower basin, shell structure, internal support structure for distribution basin, distribution trough, staircase	RCC
4	Drift Eliminators, Water stops	PVC
5	Fill	PVC/PP/ as per Bidder's proven practice
6	Fill supports	RCC/SS-316
7	Stop logs, Misc. steel structure	Refer civil specifications.
8	Hardware– All parts and embedment coming in direct contact with water/water vapor	SS 316

9	Mild steel parts or structures used in cooling tower or its vicinity	Heavily galvanized (610 gm/sq m) in accordance with IS: 2629
10	Nozzles/splash cups/orifice	PVC/ Polypropylene / Gun Metal as per IS 318 Gr VI
11	Louvers	Bidder's proven practice
12	Coarse screen	SS (min 3 mm thick)

6.00.00 Cooling Tower Basin and Shell Structure

The basin shall be designed for a water depth of at least 1.0 m from Normal Water Level with free board of at least 0.3 m above maximum water level, Cooling tower basin shall be divided into two equal parts by water tight RCC partition for cleaning and maintenance of one half while the other half is in service arrangement for drainage of water shall be provided

Cold water from cooling tower basin shall flow by gravity to open approach channel wherefrom it shall be led to the intake of CW Pump House. Two (2) Nos. Cold water channel from each compartment of basin shall be provided i.e. one each on one part of basin. Each cold-water channel shall be provided with a stop log. Suitable handling arrangement with a monorail and a chain operated hoist with a traveling trolley for the stop log shall be provided.

7.00.00 Drainage of Basin

Each half of the basin shall be sloped from center towards periphery which in turn shall be sloped towards a collecting sump to be provided on the opposite side of outlet channel. From the collecting sump, the water will be drained into a sludge sump outside the tower basin. Sludge pumps of suitable head shall be provided in the sludge sump to discharge up to clarifier sludge pit.

8.00.00 Inlet Louvers

The water loss in the inlet air openings shall be prevented with provision of adequate number of louvers of proper slope, width and spacing or alternatively by over dimensioning the cold-water basin by minimum 1.0 meter all-around. Louvers, if provided, must be properly designed to give uniform distribution of air with minimum pressure drop and must be able to withstand the corrosive atmosphere.

9.00.00 Fill and Fill Supports

1) The fill shall be of non-clogging type fills like modular splash/trickle grid/turbo splash or splash type fills like V-bar splash/splash grid and easily installable. The fills shall be adequately supported to prevent sagging and damage. The tower shall be levelled so that water will be uniformly distributed over the fills and does not cause channeling. The splash type fills shall be placed horizontally.

2) The non-clogging type fills shall be in modular form. These fills are to be mechanically assembled without any use of adhesives. Assembling by other proven method is also acceptable. The fill shall be freely rested, and bottom supported to prevent any sagging and damage.

3) The fill material shall promote a high rate of heat transfer, provide low resistance to air flow and maintain uniform water and air distribution throughout the fill volume. The fill material shall be highly resistant to deterioration and shall be fire retardant. PVC/PP fill, shall be of proven quality. The make and its properties shall be subject to Employer's approval. Bidder shall furnish details of PVC/PP fill regarding fire-retarding properties, ageing effect, vibration caused by water and wind effects. The property of PVC/PP fill shall be in line with CTI 136: 2010.

4) In case of PVC/PP fill, the material should be ultra violet ray stabilized and only virgin PVC/PP material should be used.

5) The type of fill to be supplied for this package shall be of proven design. Necessary supporting data for this shall be enclosed along with the bid.

6) Preferably, the fill shall not be extended into the air inlet area. In case the bidder's standard design calls for such an arrangement, then field performance test results of towers with comparable fill arrangement supplied by the bidder duly certified by the user shall be furnished along with the bid to establish the design.

7) Type Test of PVC/PP Material

In addition to the routine tests specified in this Technical specifications, ultra-violet exposure for 500 hours on the PVC/PP material shall be carried out for this contract once as per ASTM-G155, Test Method 3 and Impact resistance test before and after UV exposure shall be conducted as per ASTM D-256. The above type test shall be carried out by the Contractor at reputed third-party laboratory.

Offered fills shall be tested by an independent reputed laboratory approved by NTPC/Owner to validate thermal characteristic and pressure drop correlation of the offered fill. In case the bidder has their own established test facility where such tests have been conducted for other reputed clients in the past, the same is also acceptable subject to owner's approval.

Test bed shall have fill height same as the offered fill height. During testing water and air loading as well as the air velocities shall be maintained same as the duty conditions and in the range of performance guarantee conditions for which tower is designed.

10.00.00 Water Distribution System

1) The hot water distribution system of the tower shall be designed to ensure uniform distribution throughout the plan area of fill. The water should be distributed across the plan area of the fill so that no point varies more than $\pm$ 5% of the average water flow.

2) Provision shall be made for easy flushing or cleaning of all troughs/pipes. These hot water pipes shall be properly embedded in the flume or shell, as the case may be, taking into account the forces coming on them.

3) The distribution troughs/pipes shall not be laid on top of walkways.

4) All section of the water distribution system shall have adequate flow capacity to meet the maximum requirements of the thermal design of the tower.

5) Sufficient head room shall be provided between the water distribution system and packing for inspection and maintenance. Fill cone down spray / up spray water distribution system should be provided so that there is no interference between the nozzle exit and top of fill.

6) All distribution pipe work shall be adequately supported to–accommodate thermal movement while ensuring the pipe joints do not fail when subjected to pressure surges.

7) Special requirements of distribution Nozzles:

a) The Nozzles shall be arranged in a uniform pattern with proper distance to produce 15% overlapping of the individual sprays.

b) Selected nozzle characteristics like 'Head vs Flow' and 'Head vs Spread area' at three or four distances from nozzle bottom to fill top shall be furnished based on the 'Single nozzle test' and 'Four nozzle test'. Previous test reports are to be

furnished covering all tests along with the offer. In case the test was not conducted in the past, the above tests shall be carried out in presence of the Employer.

c) Single Nozzle Test: The nozzle shall be placed at the bottom of the overhead tank. The head in the tank can be maintained at different head of 0.1 m, 0.2 m and 0.3 m by adjusting the inlet flow. The water spread area for different heads and flow can be measured with the help of spread measuring instrument (scale) in LHS and RHS.

d) Four Nozzle Test: The nozzle shall be placed at the bottom of tank. The water-collecting compartment shall be placed at the bottom and center of spray nozzles. For different head, the quantity of water collected in the collecting compartments for 30 seconds/ 60 seconds shall be measured and this shall be verified with the design prediction/ assumption.

e) Nozzle connection with hot water distribution pipes shall be preferably by fasteners. Fasteners shall be of stainless steel. Push on fit type connection is not acceptable.

11.00.00 Drift Eliminators

The maximum drift loss shall be limited to 0.001% of total water in circulation. Contractor shall demonstrate during performance test as per relevant test codes that drift loss is limited to 0.001%. The drift eliminators shall be of profile type and gluing is not allowed.

12.00.00 HOT WATER PIPING, VALVES, ACCESSORIES

Main header shall be branched into two (02) nos. for feeding to each section of cooling tower. Two (2) nos. manually operated butterfly valves of suitable size shall be provided in branch pipe of each cooling tower. These valves shall be in the vertical section of hot water piping and shall be overground.

13.00.0 STOPLOG GATE AND HANDLING FACILITY

For isolation of the cold-water basin of the tower, groove for steel stop log gate shall be provided in the cold-water outlet channel of each tower.

The minimum thickness of skin plate shall be 8 mm. The structural design of the stop log gate shall generally conform to relevant IS codes. The gate shall be painted with corrosion resistant paint.

Suitable mesh size Coarse SS screen (min 3mm thick) shall also be provided in addition to trash rack to arrest cooling tower debris.

To handle the stop log gate a monorail beam at sufficient height shall be provided across each cold-water channel. A hand operated chain pulley block with travelling trolley of adequate capacity to handle the stop log gate shall be provided for each tower. The capacity of the hoist however shall in no case be less than 125% the weight of the stoplog gate.

14.00.00 MISCELLANEOUS

14.01.00 Necessary stub connections for pitot tube shall be provided in the hot water header of cooling tower for measurement of flow.

Any special equipment tools and tackles required for the successful completion of the Performance & Guarantee Test shall be included by the bidder in his scope.

15.00.00 TESTS AT SITE

After Installation at site, the complete systems/equipment will be operated at site to show satisfactory performance as required by the applicable clauses of the specification. Further, all piping shall be hydraulically tested at site.

16.00.00 **PG Test**

Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated in these specifications.

Ref PG test chapter. In addition, PG test shall be carried out by the contractor within one year of successful completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified, preferably in the period from May to September.

TECHNICAL SPECIFICATION
FOR
NATURAL DRAUGHT COOLING TOWER

(ELECTRICAL PORTION)

ANNEXURE-I

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS) REV-0, DATE: 20.05.2025

PACKAGE : COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT : 2 X 660 MW SUPER CRITICAL THERMAL POWER PROJECT, HTPS, KORBA WEST

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. Emergency power supply as available in the project is 3 phase 3 wire. Vendor to provide requirement of Emergency Power Supply for their use as per above.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for (Except for Lighting & Aviation lighting cables) 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. For Lighting & aviation lighting, refer remarks at sl. no. 11 &12.
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	
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. 3. It may please be noted that supply and E &C of ' structural steel' for supporting cabling material 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. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium

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

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
				cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.
8	Equipment grounding & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage.
9	Below grade grounding	BHEL	Vendor	MS Rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.
10	LV Motors with base plate and foundation hardware (in case applicable for NDCT)	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
11	Lighting System (incl. LDBs /ACDBs /LPs etc.)	Vendor	Vendor	**BHEL will provide the power supply (1 no. Normal & 1 no. Emergency) along with incomer cable to Vendor's LDB at one location near Cooling Tower for feeding cooling tower lighting loads. Further wires/cables (from LDB onwards)/ any other material required for lighting system shall be considered by vendor in their scope.** Vendor shall consider lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement.
12	Aviation Lighting	Vendor	Vendor	**BHEL will provide the power supply (1 no. Normal & 1 no. Emergency) along with incomer cable to Vendor's LDB (same LDB as provided for Sl. No. 11 above) at one location near Cooling Tower for feeding cooling tower aviation lighting loads. Further wires/cables (from LDB onwards)/ any other material required for aviation lighting system shall be considered by vendor in their scope.** Vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement.
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:	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval.

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

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	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 cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram			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:

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.

ANNEXURE-II

SUB-SECTION-B – 02

MOTORS

(HT MOTORS NOT APPLICABLE)

MOTORS

1.00.00 GENERAL REQUIREMENTS

1.01.00 This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A"

Degree of Protection

Degree of protection for various enclosures as per IEC60034-05 shall be as follows :-

i)	Indoor motors	-	IP 55
ii)	Outdoor motors	-	IP 55 (Additional Canopy to be provided)
iii)	Cable box-indoor area	-	IP 55
iv)	Cable box-Outdoor area	-	IP 55

2.00.00 CODES AND STANDARDS

1)	Three phase induction motors	:	IS15999/IEC:60034
2)	Single phase AC motors	:	IS 996/ IEC:60034
3)	Crane duty motors	:	IS:3177, IS/IEC:60034
4)	DC motors/generators	:	IS:4722, IS/IEC:60034
5)	Energy Efficient motors	:	IS 12615, IEC:60034-30

3.00.00 TYPE

3.01.00 **AC Motors:**

a) Squirrel cage induction motor suitable for direct-on-line starting.

b) Continuous duty LT motors upto 50 KW Output rating (at 50 deg.C ambient temperature), shall be **super Premium Efficiency class-IE4, 50-200 KW shall be of Premium Efficiency class – IE3**, conforming to IS 12615, or IEC:60034-30. HT motors shall have minimum design efficiency of 95 %. However, tolerance on this efficiency value shall be applicable as per IEC 60034

c) Motor operating through variable frequency drives shall be suitable for inverter duty with VPI insulation. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable.

3.02.00 DC Motors Shunt wound.

4.00.00 RATING

(a) Continuously rated (S1). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

(b) Whenever the basis for motor or driven equipment ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

5.00.00 TEMPERATURE RISE

Air cooled motors (AC &DC)

70 deg. C by resistance method for thermal class 155(F) insulation.

Water cooled

80 deg. C over inlet cooling water temperature mentioned elsewhere, by resistance method for thermal class 155(F) insulation.

6.00.00 **OPERATIONAL REQUIREMENTS**

6.01.00 **Starting Time**

6.01.01 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.

6.01.02 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

6.01.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.

6.01.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.

6.02.00 **Torque Requirements**

6.02.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor rated torque.

6.02.02 Pull out torque at rated voltage shall not be less than 205% of rated torque. It shall be 275% for crane duty motors.

6.03.00 NOT USED

7.00.00 **DESIGN AND CONSTRUCTIONAL FEATURES**

7.01.00 Suitable single phase space heaters shall be provided on motors rated 30KW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided. However for flame proof motors, space heater terminals inside the main terminal box may be acceptable.

7.02.00 All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). The method of movement of primary and secondary coolant shall be self-circulated by fan or pump directly mounted on the rotor of the main motor as per IEC 60034-6. However VFD driven motors can be offered with forced cooling type with machine mounted fan or pump driven by separate electric motor. Motors and EPB located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

(a) Fuel oil area : Group – IIB

(b) Hydrogen generation : Group - IIC or (Group-I, Div-II as per plant area NEC) or (Class-1, Group-B, Div-II as per NEMA /IEC60034)

7.03.00 Winding and Insulation

(a)	Type	:	Electrolytic grade Copper conductor, Non-hygroscopic, oil resistant, flame resistant Insulation.
(b)	Starting duty	:	Two hot starts in succession, with motor initially at normal running temperature. However , conveyor motors shall be suitable for 3 consecutive hot starts
(c)	11kV, 6.6 KV & 3.3 kV AC motors	:	Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15.
(d)	240VAC, 415V AC & 220V DC motors	:	Thermal Class (F) or better PAINT SHADE - RAL 5012

7.04.00 Motors rated above 1000KW shall have insulated bearings/housing to prevent flow of shaft currents.

7.05.00 Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.

7.06.00	Noise level for all the motors shall be limited to 85 dB(A) except for BFP motor for which the maximum limit shall be 90dB(A) (Tolerance limits as per IS/IEC shall be applicable on specified values). Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 . Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting vibration pads. Contractor shall ensure the adequate size of vibration pads for mounting of suitable vibration sensors.
7.07.00	In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Each bearing of HT motor shall be provided with 3 numbers duplex RTDs connected to three numbers dual input transmitters with display. However for air compressor, being high speed drive, each motor bearing shall be provided with minimum two numbers of duplex RTDs connected to two numbers dual input transmitters with display unit.
7.08.00	Motor body shall have two earthing points on diagonally opposite sides.
7.09.00	11 KV motors shall be offered with: i) Separable Insulated Connector (SIC) as per IEEE 386. The offered SIC terminations shall be provided with protective cover. SIC termination kit shall be suitable for fault level of 25 KA for 0.17 seconds. OR ii) Dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box. PSTB shall be suitable for fault level of 50KA/40KA for 0.12 seconds (Fault level shall be as per system fault level for 11 KV system defined elsewhere in the specification). Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material for single core cables) shall be provided.
7.10.00	3.3/6.6 KV motors shall be offered with dust tight phase segregated double walled (metallic as well as insulated barrier) Terminal box. Alternately Elastimold type Terminal box should also be accepted as per OEM standard proven practice. Contractor shall provide termination kit for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA/500MVA for 0.12 sec for3.3/6.6KV respectively. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.
7.11.00	The spacing between gland plate & centre of bottom terminal stud shall be as per Table-I.
7.12.00	All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
7.13.00	The motors shall be suitable for bus transfer schemes provided on the 11kV, 6.6 KV, 3.3 kV /415V systems without any injurious effect on its life.
7.14.00	For motors rated 2000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
7.15.00	NOT USED.
8.00.00	NOT USED.
9.00.00	CW motor shall be designed with minimum power factor of 0.8 at design duty point.
10.00.00	**TYPE TEST**
10.01.00	**HT MOTORS** **LIST OF TYPE TESTS TO BE CONDUCTED** **The following type tests shall be conducted on each type and rating of HT motor** (a) No load saturation and loss curves upto approximately 115% of rated voltage (b) Measurement of noise at no load. (c) Momentary excess torque test (subject to test bed constraint). (d) Full load test(subject to test bed constraint) (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp.,coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is

required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of HT motor

(a) Degree of protection test for the enclosure followed by HV and no load run test.

(b) Terminal box-fault level withstand test for each type of terminal box (phase side only) of HT motors only.

(c) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

(d) Surge-withstand test on inter-turn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

10.02.00 **LT Motors**

LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED

The following type test reports shall be submitted for each type and rating of LT motor of above 100 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip
5. Temperature rise test
6. Momentary excess torque test.
7. High voltage test
8. Test for vibration severity of motor.
9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)
10. Test for degree of protection and
11. Overspeed test.
12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

10.03.00 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

10.04.00 The type test reports once approved for any projects shall be treated as reference. For subsequent projects of Employer, an endorsement sheet will be furnished by the manufacturer confirming similarity and “No design Change”. Minor changes if any shall be highlighted on the endorsement sheet.

TYPE TEST REPORT VALIDITY 10 YEARS from the date of bid opening

These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have been witnessed by a client. However, if the vendor is not able to submit report of the type testes) conducted within 10 years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the vendor shall conduct all such tests under this contract at no additional cost to the Employer either at third party tab or in presence of Employer or his consultant representative and submit the reports for approval

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	**Minimum distance between centre of bottom terminal stud and gland plate in mm**
UP to 3 KW	**As per manufacturer's practice.**
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	385/203 (For Single core cables only)

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	**Clearance**
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

DATA SHEET-C

CLAUSE NO.	Bidder's Name …….. एनटीपीसी NTPC

DE-1B	LT MOTORS	
A.	GENERAL	
5.	Manufacturer & Country of origin. (Shall be as per approved QA make)	
6.	Equipment driven by motor	
7.	Motor type	
8.	Quantity	
B.	DESIGN AND PERFORMANCE DATA	
18.	Frame size	
19.	Type of duty	
20.	Type of enclosure /Method of cooling/ Degree of	
21.	Applicable standard to which motor generally	
22.	Efficiency class as per IS 12615	
23.	(a)Whether motor is flame proof	Yes/No
	(b)If yes, the gas group to which it conforms as per IS:2148	
24.	Type of mounting	
25.	Direction of rotation as viewed from DE END	
26.	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard (KW)	
27.	Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
28.	Maximum continuous load demand of driven	
29.	Rated Voltage (volts)	
30.	Permissible variation of :	
	a. Voltage (Volts)	
	b. Frequency (Hz)	
	c. Combined voltage and frequency	
31.	Rated speed at rated voltage and	
32.	At rated Voltage and frequency:	
	a. Full load current	

CLAUSE NO.	Bidder's Name …….. एनटीपीसी NTPC

	b. No load current	
33.	Power Factor at	
	a. 100% load	
	b. NO load	
	c. Starting.	
34.	Efficiency at rated voltage and frequrecy,	
	a.100% load	
	b. 75% load	
	c. 50% load	
35.	Starting current (amps) at	
	a. 100 % voltage	
	b. 85% voltage	
	c. 80% voltage	
36.	Minimum permissible starting Voltage (Volts)	
37.	Starting time with minimum permissible voltage	
	a. Without driven equipment coupled	
	b. With driven equipment coupled	
38.	Safe stall time with 100% and 110% of rated	
	a. From hot condition	
	b. From cold condition	
39.	Torques :	
	a. Starting torque at min. permissible voltage(kg-	
	b. Pull up torque at rated voltage.	
	c. Pull out torque	
	d. Min accelerating torque (kg.m) available	
	e.Rated torque (kg.m)	
40.	Stator winding resistance per phase (ohms at 20	
41.	GD2 value of motors	

CLAUSE NO.	Bidder's Name …….. एनटीपीसी NTPC

42.	No of permissible successive starts when motor is in hot condition	
43.	Locked Rotor KVA Input	
44.	Locked Rotor KVA/KW	
45.	Vibration limit :Velocity (mm/s)	
46.	Noise level limit (dBA)	
C.	**CONSTRUCTIONAL FEATURES**	
1.	Stator winding insulation	
	a. Class & Type	
	b. Winding Insulation Process	
	c. Tropicalised (Yes/No)	
	d. Temperature rise over specified maximum ambient temperature of 50 deg C	
	e. Method of temperature measurement	
	f. Stator winding connection	
2.	Main Terminal Box	
	a. Type	
	b. Location(viewed from NDE side)	
	c. Entry of cables(bottom/side)	
	d. Recommended cable size(To be matched with cable size envisaged by owner)	
	e. Fault level (MVA),Fault level duration(sec)	
	f. Cable glands & lugs details (shall be suitable for	
3.	Type of DE/NDE Bearing	
4.	Motor Paint shade	
5.	Weight of	
	a. Motor stator (KG)	
	b. Motor Rotor (KG)	
	c. Total weight (KG)	

CLAUSE NO.	Bidder's Name …….. एनटीपीसी NTPC

D.	**List of accessories.**	
1. 3	Space Heaters (Applicable for 30 KW & above motor) (Nos./Power in watts/supply voltage)	
2.	Terminal Box for Space Heater (Yes/No)	
3.	Speed switch (Yes/No)	
4.	Insulation of bearing (Yes/No)	
5.	Noise reducer(Yes/No)	
6.	Grounding pads	
	i) No and size on motor body	
	ii) Nos on terminal Box	
7.	Vibration pads	
	i) Nos and size	
	ii) Location	
8.	Any other fitments	
E.	**List of curves.**	
1.	Torque speed characteristic of the motor	
2.	Thermal withstand characteristic	
3.	Starting. current Vs. Time	
4.	Starting. current Vs speed	
5.	P.F. and Effi. Vs Load	
F.	**Additional Data to be filled for each rating of DC Motor**	
1.	Rated armature voltage (Volt)	
2.	Rated field excitation (Amp)	
3.	Permissible % variation in voltage	
4.	Minimum Permissible Starting voltage (volt)	
5.	At rated voltage	
	i)Full load Armature current.(Amp)	

CLAUSE NO.	Bidder's Name …….. एनटीपीसी NTPC

	ii)Full load Field current (Amp)	
	iii)No load Armature current (Amp)	
6.	Full load Field current (Amp)	
7.	No load Aramature current (Amp)	
8.	Minimum permissible field current(Amp) to avoid	
	i) Maximum permissible voltage	
	ii) Rated voltage	
	iii) Minimum Permissible Voltage	
9.	Resistance (indicative Values) in ohm	
	i)Armature winding(Arm + IP + Series) at 25	
	ii) Field Winding at 25 deg. C	
10..	Inductance (indicative values)	
	i) Armature winding	
	ii) Field winding	
11	Value of trimmer resistance (ohm) to be connected in series with the shunt field to	
	i) 220 V DC	
	ii) 250 V DC	
	iii) 187 V DC	
12	Value of the external resistance (ohm)required to be connected in series with armature during starting only	
13	Technical data sheet for external resistance box	
14	GA drawing of motor	
15	Starting time calculation	
16	Starter resistance design calculation	
17	Electrical connection diagram of motor	

ANNEXURE III

SUB-SECTION-B – 08

HT LT & CONTROL CABLES

(HT CABLES NOT APPLICABLE)

HT, LT Power Cables & Control Cables

This chapter has to be read in conjunction with sub-section B-0 "General electrical specification" of Technical specification Section- VI, Part-B and Sub-Section-IIB Electrical system/Equipment of Technical Specifications Section-VI, Part-A".

1.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes :

IS:7098 (Part -II)	Specification for Cross linked polyethylene insulated PVC sheathed cables. Part-II: For working voltages from 3.3 KV upto and including 33 KV.
IS : 3975	Low Carbon Galvanized steel wires, formed wires and tapes for armouring of cables.
IS:4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D - 2843	Standard test method for density of smoke from the burning or decomposition of plastics.
IEC-754 (Part-I)	Tests on gases evolved during combustion of electric cables.

IS :1554 - I	PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.
IS : 3961 IEC- 332	Recommended current ratings for cables Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100V.

2.00.00 TECHNICAL REQUIREMENTS

2.01.00 All cables ~~(HT Power,~~ LT power and control cables) shall be Armoured type irrespective of anything contrary mentioned elsewhere in the specification.

2.02.00 All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

2.03.00 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.

2.04.00 XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

2.05.00 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmored cables, shall have distinct extruded PVC inner sheath of black color as per IS: 5831.

2.06.00 For single core Armoured cables, armoring shall be of aluminum wires. For multicore Armoured cables armouring shall be of galvanized steel as follows : -

Calculated nominal diameter of cable under armour		Size and Type of armour
i)	Upto 13 mm	1.4mm dia GS wire
ii)	Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii)	Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv)	Above 40 & upto 55mm	1.4 mm thick GS formed wire/2.5mm dia GS wire
v)	Above 55 & upto 70mm	1.4 mm thick GS formed wire/3.15mm dia GS wire
vi)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

2.06.01 The aluminum used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm-sq.mm/mtr at 20 deg.C. The types and sizes of aluminum armouring shall be same as mentioned for galvanized steel at 2.05.00 above.

2.06.02 The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S. wire/ formed wire.

2.06.03 Distinct extruded PVC inner sheath of black color as per IS:5831 shall be provided for the cables as follows:

a) For all multicore cables.

b) For single core Armoured cables, where armouring is not being used as metallic screen.

2.07.00	Outer sheath shall be of PVC black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties. a) Oxygen index of min. 29 (Test method as per IS 10810 Part-58) b) Acid gas emission of max. 20% as per IEC-754 (Part-I) c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.
2.08.00	Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets. a. Cable lengths shall be considered in such a way that straight through cable joints is avoided.
2.09.00	For LT Power cables, multicore cables shall be allowed up to 300 Sq.mm only. All LT power cables of sizes more than 120 sq.mm. shall be XLPE insulated only, and for cable sizes up to 120 sq.mm. both XLPE insulated & PVC insulated LT power cables are acceptable. For LT cables, Same cable sizes to be used for same type & rating of motor i.e if there are three drives for one application, all three-drive motor should be provided with same cables sizes. **However due to layout constraints no of runs of same size cable may be increased.**
2.010.00	Cores of the cables shall be identified by coloring of insulation. Following color scheme shall be adopted: i. 1 core - Red, Black, Yellow or Blue ii. 2 core - Red & Black iii. 3 core - Red, Yellow & Blue iv. 4 core - Red, Yellow, Blue and Black
2.011.00	For reduced neutral conductors, the core shall be black.
2.013.00	In plant repairs to the cables shall not be accepted. Pimples, fisheye, blow holes etc. are not acceptable.
2.014.00	The cross-sectional area of the metallic screen strip/tape/wires shall be considered in sizing calculations. a. The eccentricity of the core shall not exceed 10% and ovality not to exceed 2%.

3.00.00	**CABLE SELECTION & SIZING**
3.00.01	Cables shall be sized based on the following considerations: a) Rated current of the equipment b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage c) Short circuit withstand capability
3.00.02	**Derating Factors** Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes: a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables. The bidder shall furnish detailed cable selection/sizing criteria for Employer's approval.
4.00.00	**CONSTRUCTIONAL FEATURES**
4.00.01	**11/11 KV Grade Power Cables:** Cables shall conform to IS 7098 Part-II. These cables shall be multi-stranded, compacted circular aluminum conductor, XLPE-insulated, metallic screened PVC outer sheathed. The conductor screen and insulation screen shall both be of extruded semiconducting compound and shall be applied along with the XLPE insulation in a single operation of triple extrusion process so as to obtain continuously smooth interfaces. Method of curing for 33/33 KV Cables shall be "dry curing / gas curing ". The metallic screen for each core shall be capable of carrying the system earth fault current and shall consist of copper wires or tape with minimum overlap of 20%. However, for single core Armoured cables, the armouring shall constitute the metallic part of the screening.
4.00.02	~~**6.6/6.6 kV Grade Power Cables:**~~

Cables shall conform to IS: 7098 Part - II. These cables shall be multi- stranded, compacted circular aluminum conductor, XLPE insulated, metallic screened, PVC outer sheathed. The metallic screen of each core shall consist of copper wires or tape with minimum overlap of 20%. However, for single core Armoured cables, the armouring shall constitute the metallic part of the screening. The metallic screen of each core shall be capable of carrying the system earth fault current. Method of curing for cables shall be "dry curing / gas curing / steam curing".

4.00.03 **Trailing Cables:**

Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner- sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968

4.00.04 **1.1 KV Grade Power Cables**

(a) 1.1 KV grade XLPE power cables shall have compacted aluminum conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armoured PVC outer-sheathed conforming to IS: 7098. (Part-I).

(b) 1.1KV grade PVC power cables shall have aluminum conductor (compacted type for sizes above 10 sq.mm), PVC Insulated, PVC inner sheathed (as applicable) Armoured, PVC outer-sheathed conforming to IS:1554 (Part-I).

(c) 1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber(EPR) suitable for withstanding 90 deg.C continuous conductor temperature and 250deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968.

4.00.05 **CABLE DRUMS**

a) Cables shall be supplied in steel drums of heavy construction. The drum shall be designed on the basis of weight, diameter, bending radius and length of cable. The surface of the drum and the outer most cable layer shall be covered with waterproof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection.

b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net gross weight stenciled on both sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.

c) The standard drum length for **HT power cables** with a maximum tolerance of +/- 5%, may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter for single core cable, and 750 meter for multicore cable.

d) The standard drum length of **LT power cable** with a maximum tolerance of +/- 5% may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter for single core cable excluding 630 sq.m size, and 750 meter for multicore cable & single core 630 sq.m.

e) The standard drum length for **Control cables** with a maximum tolerance of +/- 5% may be decided by the bidder subject to condition that there shall not be any joint in cable, where application length of cable is up to & including 1000 meter.

f) One drum length of each cable size can be of non-standard length (not less than 250 meter) so as to match the ordered quantity subject to condition that there shall not be any joint in cable.

5.00.00 **TYPE, ROUTINE AND ACCEPTANCE TESTS**

5.01.00 **Type Tests**

Validity of type test reports 10 years from date of bid opening.

These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have been witnessed by a client. However, if the vendor is not able to submit report of the type testes) conducted within 10 years from the date of bid opening,or in the case of type test report(s) are not found to be meeting the specification requirements, the vendor shall conduct all such tests under this contract at no additional cost to the Employer either at third party tab or in presence of Employer or his consultant representative and submit the reports for approval

The reports for the following type tests shall be submitted for one size each of LT XLPE, LT PVC Power and control cables. ~~The following type tests shall be carried out on one size each of 11/11 KV, 6.6/6.6 KV HT Cables. Size shall be decided by the employer during detailed engineering~~

SUB-SECTION-B – 10

CABLING EARTHING AND LIGHTNING PROTECTION

1.00.00 CODES AND STANDARDS

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

IS:513	Cold rolled low carbon steel sheets and strips.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubulars and other wrought steel fIttings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:2309	Code of Practice for the protection of building and allied structures against lightning.
IS:2629	Recommended practice for hot dip galvanising of iron & steel
IS:2633	Method for testing uniformity of coating on zinc coated articles
IS:3043	Code of practice for Earthing
IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in- line connectors for aluminium conductors of insulated cables
IS:8309	Compression type tubular terminal ends for aluminium conductors of insulated cables.
IS:9537	Conduits for electrical installation.
IS:9595	Metal - arc welding of carbon and carbon manganese steels – recommendations.
IS:13573	Joints and terminations for polymeric cables.
BS:476	Fire tests on building materials and structures
IEEE:80	IEEE guide for safety in AC substation grounding
IEEE:142	Grounding of Industrial & commercial power systems
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

1.02.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE, NEMA etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the

	standards alongwith copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison. Note: 3.3KV cables are not applicable for this Project.
2.00.00	**DESIGN AND CONSTRUCTIONAL FEATURE**
2.01.08	**OffSite Area** For feeder in bidder's scope for offsite areas, overhead cable tray arrangement shall be followed. However cable trenches/slit may also be acceptable, for some areas, if found to be required during detailed engineering. ~~Cable trenches provided shall be separated from fuel oil area to avoid oil accumulation~~.

2.01.09	The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.
2.01.10	Sizing criteria, derating factors for the cables shall be met as per respective chapters. However for the power cables, the minimum conductor size shall be 6 sq.mm. for aluminium conductor and 2.5 sq.mm. for copper conductor cable.
2.01.11	Conscious exceptions to the above guidelines may be accepted under special conditions but suitable measures should be taken at such location to: • Meet all safety requirements • Safeguard against fire hazards, mechanical damage, flooding of water, oil accumulation, electrical faults/interferences, etc.
3.00.00	**EQUIPMENT DESCRIPTION**
3.01.00	Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
3.01.02	Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per Clause No. 3.13.00 of this chapter.
3.01.03	Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be 3 mm.
3.01.04	Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of thickness 2 mm and shall be hot dip galvanised as per Clause No. 3.13.00 of this chapter. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.
3.01.05	The tolerance for cable tray and accessories shall be as per IS 2102 (Part-1). Tolerance Class: - Coarse
3.02.00	**Support System for Cable Trays**
3.02.01	Cable tray support system shall be pre-fabricated out of single sheet as per enclosed tender drawings.
3.02.02	Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types : (i) C1:-having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder: a) Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardwares such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc. b) The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardwares fitings and accessories shall be prefabricated factory galvanized.

c) The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvansied surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.

d) All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.

e) The typical arrangement of flexible support system is shown in the enclosed drawings and described briefly below:
The main support channel and cantilever arms shall be fabricated out of 2.5 thick rolled steel sheet conforming to IS 1079.

f) Cantilever arms of 320 mm, 620mm and 750 mm in length are required, and shall be as shown in the enclosed drawing. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.

g) Support system shall be able to withstand
- weight of the cable trays
- weight of the cables (75 Kg/Metre run of each cable tray)
- Concentrated load of 75 Kg between every support span
- Factor of safety of minimum 1.5 shall be considered

3.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Bidder without any additional cost to the Employer. The bidder shall submit the detailed drawings of the system offered by him alongwith the bid.

3.02.04 Four legged structure shall be provided wherever there is change in elevation and change in direction

3.03.00	**Pipes, Fittings & Accessories**
3.03.01	Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria.
3.03.02	GI Pipes shall be of medium duty as per IS: 1239
3.03.03	Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.
3.03.04	Hume pipes shall be NP3 type as per IS 458.
3.03.05	TERNE Coated Flexible Steel Conduits shall be water proof and rust proof made of heat resistant lead coated steel. Conduit diameter shall be uniform throughout its length. Internal surface of the conduit shall be free from burrs and sharp edges. Conduits shall be complete with necessary accessories for proper termination of the conduit with junction boxes and lighting fixtures.
3.03.06	HDPE pipes and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 part-I.
3.04.00	**Junction Boxes**
3.04.01	Junction box shall be made of Fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. The box shall be provided with the terminal blocks, mounting bracket and screws etc. The cable entry shall be through galvanized steel conduits of suitable diameter. The JB shall have suitable for installing glands of suitable size on the bottom of the box. The JB shall be suitable for surface mounting on ceiling/structures. The JB shall be of grey color RAL 7035. All the metal parts shall be corrosion protected. Junction box surface should be such that it is free from crazings, blisterings, wrinkling, colour blots/striations. There should not be any mending or repair of surface. JB's will be provided with captive screws so that screws don't fall off when cover is opened. JB's mounting brackets should be of powder coated MS. Type test reports for the following tests shall be furnished: a) Impact resistance for impact energy of 2 Joules (IK07)as per BS EN50102 b) Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb c) Class of protection shall be IP 55 d) HV test
3.04.02	Terminal blocks shall be 1100V grade, of suitable current rating, made up of unbreakable polyamide 6.6 grade. The terminals shall be screw type or screw-less (spring loaded) / cage clamp type with lugs. Marking on terminal strips shall correspond to the terminal numbering in wiring diagrams. All metal parts shall be of non-ferrous material. In case of screw type terminals the screw shall be captive, preferably with screw locking design. All terminal blocks shall be suitable for terminating on each side the required cables/wire size. All internal wiring shall be of cu. Conductor PVC wire.

3.06.00	**Cable glands** Cable shall be terminated using double compression type cable glands. Testing requirements of Cable glands shall conform to BS:6121 and gland shall be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene or better synthetic material and of tested quality. Cable glands shall be suitable for the sizes of cable supplied/erected.
3,07.00	**Cable lugs/ferrules**
3.07.01	Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections. Crimping tool for crimping (from 1.5sqmm cable to 630sqmm cables) above mentioned lugs shall be of Hexagonal Type crimp profile, with suitable die of crimp match code. Characteristics of crimping tool: 1) To should generate enough pressure to pass pull out test as per IEC 61238-1. Relevant type test to be produced for the sizes specified in the tender. 2) Tool die shall be replaceable for assorted sizes and crimp code to be mentioned on both part the die 3) Tool should be compliant of testing according to IEC, UL and GS standards Tool shall have features such as • Auto retraction system • Manual retraction stop

- Feedback signals for improper pressure
- Better battery capacity and with status display
- Flexible and rotating head for easy crimping

3.08.00 **Trefoil clamps**

3.08.01 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength, when installed at 1 mtr intervals, to withstand the forces generated by the peak value of maximum system short circuit current

3.09.00 **Cable Clamps & Ties**

3.09.01 The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyster coated ladder lock type. The clamps/ties shall have self locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.

3.10.00 **Receptacles**

3.10.01 Receptacles boxes shall be fabricated out of MS sheet of 2mm thickness and hot dipped gavanised or of die-cast aluminium alloy of thickness not less than 2.5 mm. The boxes shall be provided with two nos. earthing terminals, gasket to achieve IP55 degree of protection, terminal blocks for loop-in loop-out for cable of specified sizes, mounting brackets suitable for surface mounting on wall/column/structure, gland plate etc. The ON-OFF switch shall be rotary type heavy duty, double break,AC23 category, suitable for AC supply. Plug and Socket shall be shrouded Die-cast aluminium. Socket shall be provided with lid safety cover. Robust mechanical interlock shall be provided such that the switch can be put ON only when the plug is fully engaged and plug can be withdrawn only when the switch is in OFF position. Also cover can be opened only when the switch is in OFF position. Wiring shall be carried out with 1100 V grade PVC insulated stranded aluminium/copper wire of adequate size. The Terminal blocks shall be of 1100 V grade. The Terminal blocks shall be of 1100 V grade made up of unbreakable polymide 6.6 grade with adequate current rating and size. The welding receptacles shall be provided with RCCB/RCD of 30mA sensitivity having facility for manual testing/checking of operation of RCCB/RCD. Location and Minimum no of RC type receptacle TG and SG area shall be provided as per Annex-I attached.

3.11.00 **Cable Drum Lifting Jack**

The jack for cable drum lifting shall be of screw type with 10 ton capacity. The cable drum jacks shall be manufactured from fabricated steel. The spindles supplied with the cable drum jack shall be manufactured using BSEN-24 grade steel bar with locking collars. Jack nests shall be of SG cast steel. Cable drum jack supplied shall have undergone load testing and reports for the same shall be submitted. At least Two Nos. of jacks shall be supplied for Employer use. Contractor has to make arrangements for his own jacks for cable reeling/unreeling under his scope of installation.

3.12.00 **Galvanising**

3.12.01 Galvanising of steel components and accessories shall conform to IS:2629 , IS4759 & IS:2633. Additionally galvanising shall be uniform, clean smooth, continuous and free from acid spots.

3.12.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS:1367 . The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

3.13.00 **Welding**

3.13.01	The welding shall be carried out in accordance with IS:9595. All welding procedures and welders qualification shall also be followed strictly in line with IS:9595.
4.00.00	**INSTALLATION**
4.01.00	**Cable tray and Support System Installation**
4.01.01	Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures.
4.01.02	Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm in general. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm in general. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per the approved guidelines/ drawings. Vendor shall design the support system along with tray, spacing etc in line with tray loadings/drawings.
4.01.03	The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated
4.01.04	The contractor shall fix the brackets/ clamps/ insert plates using anchor fasteners. Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better. Anchor fastener shall be fixed as recommended by manufacturer and as approved by site engineer. For brick wall suitable anchor fasteners shall be used as per the recommendations of manufacturer. Make of anchor fasteners subject to QA approval and the same shall be finalized at pre-award stage.
4.01.05	All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/stenciled with identification numbers at every floor.
4.01.06	In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. Fabricated sections of trays, supports and accessories to make the installation complete at site shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.
4.01.07	In fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc, fire retardant paint to be applied after installation cables.
4.02.00	**Conduits/Pipes/Ducts Installation**
4.02.01	The Contractor shall ensure for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.
4.02.02	GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.
4.02.03	Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are

pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material

4.02.04 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Upto 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm and above	3.0 M

4.02.05 For bending of conduits, bending machine shall be arranged at site by the contractor to facilitate cold bending. The bends formed shall be smooth.

4.03.00 Junction Boxes Installation

4.03.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the drawings and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

4.04.00 Cable Installation

4.04.01 Cable installation shall be carried out as per IS:1255 and other applicable standards.

4.04.02 For Cable unloading, pulling etc following guidelines shall be followed in general:

a. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

b. While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.

4.04.03 Cables shall be laid on cable trays strictly in line with cable schedule

4.04.04 Power and control cables shall be laid on separate tiers inline with the approved guidelines/drawings. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable

	between trefoil center lines and clamped at every one metre. All multicore cables shall be laid in touching formation. Power and control cables shall be secured fixed to trays/support with cable clamps/ties with self locking arrangement. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by cable clamps/ties with self locking arrangement at every five meter interval and at every bend. Fibre Optical cable shall be laid in trenches/trays or as decided by Employer
4.04.05	Bending radii for cables shall be as per manufacturer's recommendations and IS:1255.
4.04.06	Where cables cross roads/rail tracks, the cables shall be laid in hume pipe/ HDPE pipe.
4.04.07	No joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Vendor shall identify and accordingly procure the cable drum length.
4.04.08	In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
4.04.09	Wherever few cables are branching out from main trunk route troughs shall be used.
4.04.10	Wind loading shall be considered for designing support as well Cable trays wherever required
4.04.11	Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures
4.04.12	The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time
4.04.13	**Separation** At least 300mm clearance shall be provided between: - HT power & LT power cables, - LT power & LT control/instrumentation cables
4.04.14	**Segregation** 1) Segregation means physical isolation to prevent fire jumping 2) All cables associated with the unit shall be segregated from cables of other units 3) Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set 4) In switchyard, control cables of each bay shall be laid on separate racks/trays
4.04.15	Minimum number of spare cores required to be left for interconnection in control cables shall be as follows: No. of cores in cable — No. of spare cores 2C,3C — 1 5C — 1 7C-10C — 2

	14C and above 3
4.04.16	**Directly Buried Cables**
	a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and joint markers. Laying of cables and providing protective covering shall be as per IS:1255 and the enclosed drawings showing cabling details.
	b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.
4.04.17	Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties with cable number heat stamped on the cable tags. The cable tag requirements mentioned above shall prevail over Tag requirements mentioned elsewhere in this document for HT power, LT power & control cables.
4.04.18	While crossing the floors, unarmoured cables shall be protected in conduits upto a height of 500 mm from floor level if not laid in tray.
4.05.00	**Cable Terminations & Connections**
4.05.01	The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Project Manager. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site
4.05.02	Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Project Manager.
4.05.03	The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.
4.05.04	Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

4.05.05 All the cores of the control cable to be terminated shall have identification by providing ferrules at either end of the core, each ferrule shall be indelible, printed single tube ferrule and shall include the complete wire number and TB number as per the drawings. The ferrule shall fit tightly on the core. Spare cores shall have similar ferrules with suffix sp1, sp2, ---etc along with cable numbers and coiled up after end sealing.

4.05.06 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

5.00.00 EARTHING SYSTEM

5.01.00 Earthing system shall be in strict accordance with IS:3043 and Indian Electricity Rules/Acts. The earthing system shall be designed for a life expectancy of at least forty (40) years, for a system fault current of 63 kA for 1.0 sec. The minimum rate of corrosion of steel for selection of earthing conductor shall be 0.12mm per year.

Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All areas under contractor scope of supply shall be interconnected together by minimum two parallel conductors. The Contractor shall furnish the detailed design and calculations for Employer's approval. Contractor shall obtain all necessary statutory approvals for the system. All the columns shall be earthed by nearby risers and earthmat grid spacing shall be maximum 15 mts. Minimum two nos of risers shall be provided for each equipment in SG area. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose. Sufficient nos of risers near the equipment shall be provided as per the system requirement. Ring type earthing around the offsite building shall be provided with interconnection of with main grid at minimum two points.

5.02.00 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.

5.03.00 The material of the earthing conductors shall be as follows:

1. Conductors above ground level and in built up trenches. - Galvanized steel
2. Conductors buried in earth - Mild steel
3. Earth electrodes - Mild steel rod

5.04.00 The sizes of earthing conductors for various electrical equipments shall be as below:

Equipment	Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
i. Main earth grid	Min 40 mm dia. MS rod or as per actual calculation whichever is more	65 x 8mm GS flat
ii. 33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and 415V switchgear	---	65 x 8mm GS flat
iii. 415 V MCC/ Distribution boards / Transformers	---	50 x 6mm GS flat
iv. LT Motors above 125 KW	---	50 x 6mm GS flat

	25 KW to 125 KW	---	25 x 6mm GS flat
	1KW to 25 KW	---	25 x 3mm GS flat
	Fractional House power motor	---	8 SWG GS wire
v.	Control panel & control desk	---	25 x 3 mm GS flat
vi.	Push button station / Junction	---	8 SWG GI wire
vii.	Columns, structures, cable trays and bus ducts enclosures	---	50 x 6mm GS flat
viii.	Crane, rails, rail tracks & other non-current carrying metal parts		25 x 6mm GS flat

5.05.00 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity, Crane rails, tracks, metal pipes and conduits shall also be effectively earthed at two points. Steel RCC columns, metallic stairs and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing ensured by bonding the different sections of hand rails and metallic stairs. Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise approved. Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post. Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations. Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable.

5.06.00 Each continuous laid lengths of cable tray shall be earthed at minimum two places by G.S. flats to earthing system, the distance between earthing points shall not exceed 30 meter. Wherever earth mat is not available, necessary connections shall be done by driving an earth electrode in the ground.

5.07.00 Neutral points of HT transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors.

5.08.00 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.

5.09.00 Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.

5.10.00 Suitable earth risers as approved shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

5.11.00 Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding.

5.12.00 Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

5.13.00 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm.

All earthing in BOP area shall be treated earth pits as per latest Indian Standard and IEEE guidelines.

5.14.00 Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

5.15.00 A minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Earthing conductors crossings the road can be installed in pipes. Wherever earthing conductor crosses or runs at less than 300 mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.

5.16.00 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively.

5.17.00 Earth pit shall be of treated type & shall be constructed as per IS:3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal as per IS:3043. Test links shall be provided with bolted arrangement along with each earth pit, in order to facilitate measurement of earth resistance as & when required.

5.18.00 On completion of installation continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured and recorded. All equipment required for testing shall be furnished by contractor.

5.19.00 Earthing conductor shall be buried at least 2000mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead.

5.20.00 Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043	
Earthing System		
Life expectancy	40 Years	
System Fault Level	System Fault Level 63 KA for 1 sec	
Soil resistivity	Actual as per site conditions	
Min. Steel corrosion	0.12mm/year	
Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.	
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.	
Surface resistivity	- Gravel	3000 ohm-meter
	- Concrete	500 ohm-meter

Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection

6.00.00 LIGHTNING PROTECTION SYSTEM

6.01.01 Lightning protection system shall be in strict accordance with IEC : 62305 and latest IS standards.

6.01.02 Lightning conductor shall be of 25x6mm GS strip when used above ground level and shall be connected through test link with earth electrode/earthing system.

6.01.03 Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.

6.02.00 **Down Conductors**

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.
2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
3. All joints in the down conductors shall be welded type.
4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1500 mm.
6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
7. Lightning conductors shall not pass through or run inside GI Conduits.
8. Testing link shall be made of galvanized steel of size 25x 6mm.
9. Pulser system for lightning shall not be accepted.
10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.

7.00.00 **TESTS** validity of type test reports 10 years from date of bid opening*

7.01.00 **Type Test reports shall be furnished for the following**

7.01.01 Type tests on Cable Trays support system

a) **Test 1A:**
On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 meter length of main support channel shall be fixed vertically at each end to a rigid structure as per the fixing arrangement as shown in the enclosed drawing. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the points shown in the enclosed drawings and at the following load intervals:

i. Working load
ii. Working load + point load
iii. Off load
iv. Proof load + point load
v. Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) **Test 1B**
Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a) **Test 2A:** A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per the fixing arrangement as shown

* These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have been witnessed by a client. However, if the vendor is not able to submit report of the type tests conducted within 10 years from the date of bid opening,or in the case of type test report(s) are not found to be meeting the specification requirements, the vendor shall conduct all such tests under this contract at no additional cost to the Employer either at third party tab or in presence of Employer or his consultant representative and submit the reports for approval

in the enclosed drawing. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i. Working load
ii. Working load + point load
iii. Off load
iv. Proof load + point load
v. Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) **Test 2 B:** The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side

Test 3: Tests on Channel Fixed on Beam/Floor

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as shown in the drawing enclosed and as detailed below:

a) Test 3A: A length of steel structure shall be rigidly supported. It should be fitted on a meter length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place

b) Test 3B: With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place

c) Test 3C: With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line

The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded

Test 4 : Channel Insert Test

A 2.5 m length of C1 channel fixed to the concrete wall/ steel structure as per actual site installation conditions. 6 nos. of 750 mm cantilever arms shall be attached to C1 channel as shown in enclosed drawing. Each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at points shown in the enclosed drawings at the following load intervals.

i. Working load
ii. Working load + point load
iii. Off load
iv. Proof load + point load
v. Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

Test 5 : Channel nut slip characteristics (what ever applicable)

Tests 5A1,5A2,5A3 : A length of channel C1 section 200mm long shall have fitted bracket with the two bolt fixing as shown in drawing enclosed.
With loads applied at the position shown in drawing enclosed nut slip shall be determined with bolt torque of 30NM, 50 NM and 65 NM No fewer than three measurements shall be made for each torque setting.
A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM

Tests 5B1,5B2,5B3: The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing as shown in drawing enclosed. With loads applied at the position shown in drawing, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 6 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

7.02.02 Cable termination kit and straight through joints should have been tested as per IS:13573 for 3.3kV grade & above.

7.03.00 **Routine/ Acceptance Tests**

7.03.01 Routine Tests

a) Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification

b) Physical & dimensional check on all equipments as per approved drawings/standards

c) HV/IR as applicable

d) Check/measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard

7.03.02 Acceptance Test

a) Galvanising Tests as per applicable standards
b) Welding checks
c) Deflection tests on cable trays

One piece each of 2.5m length of cable tray of 300mm & above shall be taken as sample from each offered lot. It shall be supported at both end & loaded with uniform load of 76 kg/meter

along the length of cable tray. The maximum deflection at the mid-span of each size shall not exceed 7mm

d) Proof load tests on cable tray support system
   i. Tests on Main Support Channel shall be done if only C1 Channel are in scope of supply and cantilever arms shall be fitted on one side. This test shall be same as test 4 of type test.
   ii. Test on Main Support Channel shall be done with C2 channel and cantilever arms fitted on both sides, if C2 channels are in scope of supply. This test shall be same as test 2A of type test. Then test (i) above shall not be done.
   iii. Nut slip characteristic test (it shall support minimum load of 350kg before nut slips with a bolt torque of 65 NM). This test shall be same as test 5B3 of type test

   The procedure for carrying out tests at "d" above shall be as per details given in Type Tests in specification thereafter Die-Penetration test shall be carried out to check weld integrity

e) The above acceptance tests shall be done only on one sample from each offered lot.

8.00.00 COMMISSIONING

8.01.01 The Contractor shall carry out the following commissioning tests and checks after installation at site. In addition the Contractor shall carry out all other checks and tests as recommended by the Manufacturers or else required for satisfactory performance

8.01.02 **Cables**

i. Check for physical damage
ii. Check for insulation resistance before and after termination/jointing
iii. HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning
iv. Check of continuity of all cores of the cables
v. Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.
vi. Check for correct polarity and phasing of cable connections
vii. Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
viii. Check for provision of correct cable tags, core ferrules, tightness of connections

8.02.00 Cable trays / supports and accessories

1. Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
2. Check for continuity of cable trays over the entire route.
3. Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
4. Check for earth continuity and earth connection of cable trays.

8.03.00 Earthing and Lightning protection system

1. Earth continuity checks.
2. Earth resistance of the complete system as well as sub-system.

SUB-SECTION-B – 11

LIGHTING

1.00.00 GENERAL

1.01.00 This specification covers the general description of design, manufacture and construction features, testing, supply, installation, and commissioning of the Station Lighting system equipment.

2.00.00 CODES AND STANDARDS

2.01.00 All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.

2.02.00 Lighting Fixtures and Accessories

IS:1913	General and safety requirements for luminaries.
IS:2148	Flame proof enclosures of electrical apparatus.
IS:1534	Ballast for fluorescent lamps.
IS:1777	Industrial luminaire with metal reflectors.
IS:2418	Tubular fluorescent lamps for general lighting services.
IS:4013	Dust-tight electric lighting fittings.
IS:8224	Electric Lighting fittings for Division 2 areas.
IS:10276	Edison screw lamp holders.
IS:10322	Luminaires.
IS:13021	AC Supplied Electronic Ballasts for tubular fluorescent lamps.
IS 16103	LED Luminaire Standards

2.03.00 Lighting Panels, Switchboxes, Receptacles and Junction Boxes

IS:2147	Degree of protection provided by enclosures for low-voltage switchgear and control gear.
IS:1293	Plugs & socket outlets of rated voltage upto and Including 250volts & rated current upto and including 16 Amps.
IS:2551	Danger notice plates.
IS:13947	Low voltage switchgear and control-gear
IS:3854	Switches for domestic and similar purposes.
IS:6875	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V AC and 1200 V DC.
IS:13703	Low voltage fuses for voltages not exceeding 1000V AC or 1500 V DC.

2.04.00 **Conduits, Pipes and Accessories**

IS:2667	Fittings for rigid steel conduit for electrical wiring.
IS:3837	Accessories for rigid steel conduits for electrical wiring.
IS:9537	Conduits for electrical installations.

2.05.00 **Lighting Wires/Cables**

IS:694	PVC insulated cables for working voltages upto and including 1100 V
IS:3961	Recommended current ratings for cables.(PVC Insulated and PVC sheathed heavy duty cables and light duty cables).
IS:8130	Conductors for insulated electric cables and flexible cords.

IS:10810 Methods of tests for cables.

2.06.00 **LED Luminaries**

16101:2012 General Lighting. LEDs and LED modules Terms and definitions

16102(Part 1):2012 Self Ballasted LED Lamps for General Lighting Services.
Part-1 Safety Requirements.

16102(Part 2):2012 Self Ballasted LED Lamps for General lighting Services.
Part-2 Performance Requirements.

16103(Part I):2012 LED modules for General lighting Safety Requirements.

15885(Part 2/Sec. 13) :2012 Lamp control gear Part 2 particular Requirements Section 13 d.c. or a.c. Supplied Electronic control gear for LED modules

16104:2012 d.c. or a.c. Supplied Electronic control gear for LED modules - Performance Requirements.

16105:2012 Method of Measurement of Lumen maintenance of Solid-state Light (LED) Sources.

16106:2012 Method of Electrical and photometric Measurements of Solid State Lighting (LED) Products

16107:2012 Luminaires Performance

16108:2012 Photo-biological safety of Lamps and Lamp Systems

	IS 513	Cold rolled low carbon steel sheets and strips
	IS 12063	Classification of degree of protection provided by enclosures.
	IS 14700	Electro magnetic compatibility (EMC) – Limits (Part 3/Sec. 2) for Harmonic current emission – THD < 15% (equipment, input current < 16 Amps. per phase.
	IS 9000 (Part 6)	Environment testing: Test Z – AD: composite temperature/humidity cyclic test.
	IS 15885 (Part 2/Sec. 13)	Lamp control gear: particular requirements for DC or AC supplied electronic control gear IS 16004 – 1 and 2) for LED modules.
	IS 4905	Method for random sampling
2.07.00	**Electrical Installation Practices & Miscellaneous**	
	IS:1944	Code of practice for lighting of public thorough fare
	IS:3646	Code of practice for interior illumination.
	IS:5572	Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation
	S:6665	Code of practice for industrial lighting.
	.	National Electrical Code
	-	Indian Electricity Rules.
		Indian Electricity Act

	IS:5	Colour for ready mixed paints & enamels.
	IS:280	Mild steel wires for general engineering purposes.
	IS:374	Electric ceiling type fans & regulators.
	IS:732	Code of practice for electrical wiring installations.
	IS:1255	Code of practice for installation and maintenance of power cables Upto and including 33KV rating.
	IS:2062	Steel for general structural purposes
	IS:2629	Recommended practice for hot-dip galvanizing of iron and steel.
	IS:2633	Methods for testing uniformity of coating of zinc coated articles.
	IS:2713	Tubular steel poles for overhead power lines.
	IS:3043	Code of practice for earthing
	IS:5216	Guide for safety procedures and practices in electrical work.
	IS:5571	Guide for selection of electrical equipments for hazardous areas.
	BS:6121	Mechanical cable glands

3.00.00 LIGHTING SYSTEM DESCRIPTION

3.01.00 The illumination of various indoor and outdoor areas in the main plant & offsite area shall be provided as described here. The lighting system of various areas shall comprise of the following systems as identified in Annexure-B:

(a) Normal AC Lighting System

(b) Emergency AC Lighting System

(c) DC Lighting System

3.02.01 **Normal AC Lighting System**

Normal AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels (LPs) which in turn will be fed from the lighting distribution boards (LDBs)/Switch board MCC.

3.02.02 **Emergency AC Lighting System**

This system shall be provided for certain important areas in the main plant. The lighting fixtures connected to this system shall be normally "ON" along with the normal AC system. These will be fed from emergency lighting panels (ELPs) which in turn will be fed 3-phase, 4-wire supply from the emergency lighting distribution boards (ELDB'S). These lights will go off for a few seconds in case of AC supply failure at Emergency Switchgear, but shall be automatically restored when Emergency Switchgear is energised by Diesel generator set.

3.03.00 **DC Lighting System**

3.03.01 At strategic locations in the main plant, a few lighting fixtures fed from 220V, DC supply, shall be provided to enable safe movement of operating personnel and access to important control points during an emergency, when both the normal AC and Emergency Lighting system fail. These lighting fixtures will be fed from 220V DC LDBs which in turn will be fed from DC lighting panels.

3.03.02 The supply to the DC lighting panels shall be automatically switched ON in case of loss of AC supply at station service switchgear as well as Emergency switch-gear. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply to normal AC or emergency AC lighting system.

3.03.03 Emergency DC lighting is to be provided, through self-contained DC emergency fixtures with four hours back-up duration, at strategic locations, in auxiliary/offsite buildings wherever DC supply system is not available. The fixtures shall be switched 'ON' automatically in case of failure of AC supply.

3.03.04 For Coal Handling plant/FGD Plant Area

18W, 220V DC Lighting fixture shall be provided in underground portion of conveyor, each switchgear room, control room, office room, pump house, each drive floor of TPs, staircases of various TPs and buildings and each local control area. DC lighting fixtures shall be fed from 220V DC LDB which in turn will be fed from CHP DC system. The supply to the DC lighting panels shall be automatically switched ON in case of loss of normal AC supply.

4.00.00 DESIGN PHILOSOPHY

1. A comprehensive illumination system shall be provided in the entire project areas under bidder's scope.

2. All outdoor lighting system shall be automatically controlled by synchronous timer. Provision to bypass the timer shall be provided in the panel.

3. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, lighting pole/masts, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting, including Transformer yard & Switch yard area, aviation obstruction lighting, Street lighting, security lighting, etc. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.

4. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The lighting fixtures shall be designed for minimum glare. The design shall prevent glare/luminous patch seen on VDU/ Large video screens, when viewed from an angle. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by

reflection. The diffusers/ louvers used in fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period. The Lux levels to be adopted for various area are indicated at Annexure - A. (placed at the end of this Chapter).

5. Different Lighting Systems envisaged for various plant areas are indicated in Annexure-B: While finalizing the detailed layout of lighting fixtures, the position/location and layout of equipments should be taken into account to have adequate illumination at desired locations. For CCR room Dimmable and Tunable downlighter fittings to be provided.

6. **LED Luminaires:**

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for DC lighting, hazardous areas & aviation lighting etc. conventional/LED type luminaires shall be used. However, aviation light in Lighting Mast shall be of LED type. In false ceiling area LED luminaires shall be recessed mounting type & in non-false ceiling area the LED luminaires shall be surface mounting type.

The individual lamp wattage for LED shall be upto 3 watt. Fractional wattage LEDs are also acceptable. The LED chip efficacy shall be min 120 Lm/W. The luminaire efficacy shall be not less than 100 Lm/W. Suitable heat sink shall be designed & provided in the luminaire. The LED used in the luminaires shall have colour rendering index (CRI) of Min 80. Colour designation of LED shall be "cool day light" (min 5700K) type for indoor areas. However for outdoor areas, the colour temperature of LED shall be min. 4000K, including rough & dust prone areas. The LED luminaries shall have a minimum life of 25000 burning hours with 80% of lumen maintenance at the end of the life. LED shall conform to the LM 80 requirements.

The max. junction temperature of LED shall be 85 deg C. Further the lumen maintenance at this temperature shall be min 90%. The THD of LED Luminaires shall be less than 10%. Further the EMC shall be as per IS 14700. The power factor of the luminaire shall not be less than 0.9. The marking on luminaire & safety requirements of luminaire

shall be as per IS standards. Suitable heat sink with proper thermal management shall be designed & provided in the luminaire.

The connecting wires used inside the system, shall be low smoke halogen free, fire retardant type and fuse protection shall be provided in input side specifically for LED luminaires.

Care shall be taken in the design that there is no water stagnation anywhere in the housing of luminaire. The entire housing shall be dust and waterproof protection as per IS 12063.

7. **Driver Circuit**

LED modules and drivers shall be compatible to each other. The LED module driver's ratings and makes shall be as recommended by corresponding LED chip manufacturer.

LED Drivers shall have following control & protections: -

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

8. Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for fixtures located in non air conditioned area.

(a.) Office area (air conditioned) : 0.8

(b.) Office area (non air conditioned) and other indoor area : 0.7

(c.) Dust prone indoor and outdoor area : 0.6

(d.) Coal Handling area, Ash Handling Conveyor /Transfer Points etc. : 0.5

e.) Boiler Area : 0.6

Reflectance Factor:-

Ceiling :0.8

Wall : 0.5
Floor : 0.2

Reflectance factor for CHP areas such as Bunker floor, TPs etc and AHP outdoor areas :-

Ceiling :0.3
Wall :0.3
Floor :0.1

9. (i) All outdoor fixtures shall be weather proof and of min. IP65 degree of protection.

(ii) For Indoor type of fixtures:-

(a) Surface/Pendent mounting: - IP 54 class of protection.

(b) Recess Mounting (False ceiling):- IP 20 class of protection.

10. (a) Lighting panels shall be constructed out of 2 mm thick CRCA sheet steel. The door shall be hinged and the panel shall be gasketted to achieve specified degree of protection. Lighting panels shall be powder coated with color shade RAL9002. Lighting panels shall have min. IP55 degree of protection.

(b) All MCBs/Isolators/Switches/Contactors etc. shall be mounted inside the panel and a fibre glass sheet shall be provided inside the main door such that the operating knobs of MCBs etc., shall project out of it for safe operation against accidental contact.

(c) Terminal bocks shall be 1100 V grade, clip-on stud type, made up of polymide 6.6 or better suitable for terminating multicore 35 or 70 Sq. mm. stranded aluminium conductor incoming cable and 10 Sq. mm. stranded aluminium conductor for each outgoing circuits voltage. All terminals shall be shrouded, numbered and provided with identification strip for the feeders.

(d) MCB's shall be current limiting type with magnetic and thermal release suitable for manual closing and automatic tripping under fault condition. MCB's shall have short circuit interrupting capacity of 9 KA rms. MCB knob shall be marked with ON/OFF indication. A trip free release shall be provided to ensure tripping

on fault even if the knob is held in ON position. MCB terminal shall be shrouded to avoid accidental contact.

(e) Contactors of AC lighting panels shall be 3 no's,63 A, single pole continuous duty MCB, with neutral link,load make-break type suitable for 415 V, 3 phase 4 wire system.

(f) DC switches shall be rotary type, 2 pole, continuous duty, load break type, quick make quick break, suitable for 220 V DC, 2 wire system. Switch knob shall be provided with ON/OFF indication.

(g) Programmable Digital Timer shall be Electronic Astronomical Almanac Time switch with battery backup of min. TEN years, 4 Digit LED display, 24 hours range, manual override facility, 10 Amp 3 relay output, with NO/NC Contacts suitable for operation on 240V single phase AC supply.

(h) Each lighting panel (LP-3) shall be fed from a 415V/42V, 3 phase-4 wire, 3 KVA transformer. The transformer shall be located inside the lighting panel itself. Transformers shall be dry type, natural air cooled with class F insulation or better. Impedance of transformer shall be 5%. Transformers shall be tested as per IS:11171. Off-circuit tap changer with +/- 5% in steps of +/- 1.25% tapping shall be provided. One minute power frequency withstands voltage for lighting transformer shall be 2.5 KV.

(i) Lighting Panels shall have 20% spare outgoing feeders and shall be of following types:-

TYPE	INCOMER FEEDER	OUTGOING FEEDERS	DETAILOFCONTENTS
LP-1	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	18Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection

LP-2	3No. 415V, 63 A, SP MCB (31/2Cx70sq.mm cable)	9 Nos.,20A, 240V MCB	415V, 63A(min.), AC2 duty contactor and Programmable Digital Timer of 24 hour range 10A, 240V selector switch, fuse, etc. outdoor type and IP:55 degree of protection
LP-3	1 No., 4A fuse 3 KVA transformer,40A TPN MCB	24 Nos., 16A, 45V MCB	IP 55 degree of protection. Incomer shall be suitable for receiving 4Cx16 sq. mm cable and outgoing circuit shall be suitable for 2Cx16 sq. mm cable.
LP-D1	1No. 220V,32 A, DP Isolator (2Cx35sq.mm cable)	6Nos.,16A, 220V DP Switch & Fuse	220V,32A DC Fuse, etc. outdoor type IP:55 degree of protection.

11. Wires of different phase shall normally run in separate conduit.

12. Power supply shall be fed from 415 / 240 V normal AC supply, emergency AC supply and 220V DC supply through suitable number of conveniently located lighting distribution boards (LDB) and lighting panels (LP). AC lighting supply shall be isolated from main supply by 2x100% isolation transformers of max. rating of 50 KVA for 10/15 nos. outgoing feeder with changeover switch facility. The isolation transformer shall be fed from two different bus sections of MCC and fault level restricted to 3 KA at Lighting Panels.

13. Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. Further 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial areas.

Suitable number of 63A, 3ph, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A, 3ph, 415V AC receptacle shall be provided in each floor of off-site buildings/ structures.

Receptacles boxes shall be fabricated out of 2 mm thick MS steel hot dip galvanized or of not less than 2.5 mm thick die-cast aluminium alloy or fabricated out of 2 mm thick CRCA sheet with electro static powder coating. IP-degree of protection shall be applicable to receptacles Type 'RA &''RC' only.

Minimum no of receptacle in TG and SG area shall be provided as per Annex-I, of chapter B-10.

Receptacles shall be of following types:

Type	Switch rating	Socket& plug rating	Type & make of plug & Socket	Terminal Block size
RA	20 A, SP240V AC(Industrial)	20A, 3 pin240 V AC	Employer appd. make	1-4 way, suitable for loop-in loop- out of 10 sq.mm. Al. Conductor
RB	16A, S.P240V AC	6A+16A6 Pin decorative Piano-key Type Switch	Emp[loyer appd.make	1-4 way, suitable for loop-in loop- out of upto 10 sq.mm. Al. Conductor

RC	20 A, SP24 V AC(Industrial)	20A, 3 pin24 V AC	Employer appd. make	1-4 way, suitable for loop-in loop- out of 2 core -16 sq.mm. Al. Cable.

14. In the hazardous areas like Hydrogen generation plant, fuel oil handling areas or any other gas/ liquid fuel storage/ handling areas in bidder's scope, lighting shall be flame proof.

15. The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group II C as per IS: 2148 or class I, Division II as per NEC 70-428.

16. All fluorescent lamps shall be have "Cool day light" colour designation. The mirror optics type fluorescent fixtures shall have no iridescence effect. Fixtures with better efficiency and upgraded proven system may also be considered

In candescent lamps may be used only with DC Lighting.

17. Aviation warning lights shall be provided as per the recommendations of ICAO and Director general of civil aviation, India. The arrangement of light should be marked such that the object is indicated from every angle in azimuth. The aviation warning lighting system shall also conform to the latest Indian standard IS 4998.

18. Contractor shall demonstrate the average lux level achieved for different areas as per specification requirements, after completion of the lighting work, at site to the satisfaction of engineer-in-charge.

4.01.00 -**NOT USED**.

4.02.00 All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.

4.03.00	**Fans & Regulator**
4.03.01	Ceiling Fans, to be provided in non air-conditioned office/control room area. Further tentatively one (1) no. ceiling fan shall be provided for 10 sq.m area, at suitable mounting height. The ceiling fans shall be suitable for operation on 240 V +/-10%, 50 Hz, AC supply comprising of class 'E' or better insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced AL blades (3 Nos.), down rod, BEE 5 star rated,die cast aluminium housing, capacitor, suspension hook, canopies etc. finished in stove enameled white or with electro static powder coating. Power factor of fans shall not be less than 0.9. Fan regulators shall be stepped electronic type suitable for operation on 240V +/-10% AC supply.
4.04.00	**Junction Boxes, Conduits, Fitting & Accessories, Pull Out Boxes:**
	Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type. Junction boxes for street lighting poles and lighting mast if applicable , shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55. All switches and receptacles upto 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox & plate. Conduits, Pipes and Accessories Galvanised heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered. Conduits in walls and ceilings in buildings with RCC and masonry structure such as Administrative, Service, Canteen, Time Office, Auditorium, IT building etc shall be concealed.Rigid steel conduits shall be heavy duty type,hot dip galvanised conforming to IS : 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside. Flexible conduit shall be water proof and rust proof made of heat resistant steel with temperature rating of 150 deg.C.

	Pull out boxes shall be provided at suitable interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, Structures, etc.. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 52 degree of protection. Pull out box & its cover shall be hot dip galvanized.
4.05.00	**Lighting Wires**
4.05.01	Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminium.
4.06.00	**Lighting Poles**
4.06.01	The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. The Poles shall be mounted above ground using base plate and minimum height of pole shall be 8 mtrs The poles shall be hot-dip galvanized as per IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole. The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.
4.07.00	**Lighting Masts**
4.07.01	Suitable number of lighting masts shall be provided for entire plant..Lighting Mast shall be of continuously tapered polygonal cross section hot dip galvanised. The Mast shall be of 30 M or suitable height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaires, suitable aviation warning light, lightning alongwith

	necessary power cables within the mast. The mast shall be delivered in not more than three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast The Mast together with the fixtures shall be capable of withstanding the appropriate wind loads as per IS: 875. The Mast shall be fabricated from special steel plates conforming to BS-EN10-025 and folded to form a polygonal section. Suitable feeder pillar with TPN MCB, contactors, timer, MCB and other necessary accessories for operation & protection of the mast and fixtures shall be provided.
4.08.00	Lighting fixtures shall generally be group controlled directly from lighting panel. However, in office areas, control shall be provided through switch boxes. Each switch shall control a maximum of three fluorescent fixtures.
4.09.00	A.C. normal, AC emergency and DC system wiring shall run throughout in separate conduits. Wires of different phase shall run in different conduits.
4.10.00	Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run alongwith each conduit run. Cable armours shall be connected to earthing system at both the ends.
4.11.00	Alternately Vendor may offer technically superior and proven product subject to approval of employer.
4.12.00	**Occupancy based Passive Infra-red sensors.** Reliable occupancy based passive Infra-red sensor shall be provided in air-conditioned office rooms suitable to acter the controlled lighting systems. The detection area shall be minimum 5 meter for standard room height of 3 meter. All the calibrated settings shall be stored in non-volatile memory of PIR Sensor which shall be unaffected by power supply fluctuations. If necessary, contractor shall be supplied along with sensor and many be located inside the swotchbox/panel.

5.00.00 **TESTS**

5.01.00 **For LED Fixture**

a) The contractor shall carry out the type tests as listed in this specification on the following types of LED fixtures to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of bid document and the same shall be considered for the evaluation of the bids.

LED fixtures (Type test shall be conducted on one rating each of following type of LED fixtures. Rating for test conduction shall be decided by the employer during detailed engineering)

a) High bay fixture.
b) Well glass fixture.
c) Street light fixture
d) Surface mounted type fixture.
e) Recessed mounted type fixture.

The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.

5.02.00 **For all other Station lighting equipment:**

5.03.00 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

5.04.00 Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S

5.05.00 Type test reports of the following items as per technical specification requirements/ standards shall be submitted for approval.

a) validity of type test reports 10 years from date of bid opening
b) These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the tests should have been either conducted at an independent laboratory or should have been witnessed by a client. However, if the vendor is not able to submit report of the type testes) conducted within 10 years from the date of bid opening,or in the case of type test report(s) are not found to be meeting the specification requirements, the vendor shall conduct all such tests under this contract at no additional cost to the Employer either at third party tab or in presence of Employer or his consultant representative and submit the reports for approval.

SL NO.	DESCRIPTION
i.	Lighting fixtures of each type
ii.	Lighting panel of each type (Degree of Protection)
iii.	Junction Box of each type.

Type test reports for LED as per standards for following shall be submitted for approval.

1. Visual and Dimension check
2. Proof of procurement of LEDs
3. Safety tests
a) Marking
b) Construction
c) Provision for Earthing
d) External and Internal wiring
e) Protection against electrical shock
f) Endurance and Thermal
g) Insulation resistance & electrical strength
h) Resistance to heat fire & tracking
i) Resistance to Humidity
4. Fire Retardant test
5. Performance tests (electrical, Photometric color and Life)
6. Burn-in Test

7. Power Cycling
8. Temperature rise test
9. Emission Tests
a) Radiated & conducted emission
b) Harmonics & flickers
10. Immunity tests

In addition, following test reports to be submitted for LED chip/LED luminaire:

a) LED parameters like Lumen per watt, CRI, Beam angle from manufacturer.

b) LM 80/IS: 16105 report.

c) LM 79/IS: 16106 report.

5.06.00 Acceptance Test and Routine Test

5.06.01 All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.

5.06.02 Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks also. Switch boxes shall be made of 1.6 mm thick MS sheet with 3 mm thick decorative, Perspex cover. Switch box shall be hot dip galvanized.

Switch boxes shall be of following types :

No.	TYPE	Switch Regulator*	Fan	Socket
1	SWB	5 A - 2 Nos.	-	-
	SWB 2	5 A - 3 Nos.	-	5A - 1.No.

3*	SWB	5 A - 5 Nos.	1	5A - 1.No
4*	SWB	5 A - 7 Nos	3	5A - 1.No.
5**	SWB	5 A - 5 Nos	-	5A - 1.No.

* Space provision shall be kept for fan regulator in switch boxes.

** Shall have the provision for mounting the 16 A contactor.

5.07.00 **Galvanizing Tests**

5.07.01 The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.

5.07.02 In addition following tests shall be conducted as acceptance tests.

(a) Uniformity of coating - The coating of any article shall withstand for one (1) minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.

(b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually.

(c) In addition, the plating thickness shall be determined microscopically/ chemically or electronically.

6.00.00 COMMISSIONING CHECKS

1. On completion of installation work, the Contractor shall request the Project manager for inspection and test with minimum of fourteen (14) days advance notice.

2. The Project manager shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect

pointed out during such inspection shall be promptly rectified by the Contractor.

3. The installation shall be then tested and commissioned in presence of the Project manager.

4. The contractor shall provide all, men material and equipment required to carry out the tests.

5. All rectifications repair or adjustment work found necessary during inspection, testing and commissioning shall be carried out by the Contractor without any extra cost. The handing over the lighting installation shall be effected only after the receipt of written instruction from the Employer/his authorized representative.

6. The testing shall be done in accordance with the applicable Indian Standards and codes of practices. The following tests shall be specifically carried out for all lighting installation.

   (a) Insulation Resistance.

   (b) Testing of earth continuity path.

   (c) Polarity test of single phase switches.

   (d) Functional checks.

7. The lighting circuits shall be tested in the following manner:

   (a) All switches ON and consuming devices in circuit, both poles connected together to obtain resistance to earth.

   (b) Insulation resistance between poles with lamps and other consuming devices removed and switches ON.

LUX LEVEL FOR NDCT

Sl. No.	Location	Average Illumination Level (Lux)	Type of Fixture
1	NDCT Switchgear (LDB/ACDB/LP) room (if any)	200	Industrial type LED
2	Stairways and landings	100 ([minimum one (1) light fixture at each Landing)	Well glass type LED fixture
3	Building Periphery Lighting	10	LED Street Light fixture/ LED Luminaire

AVIATION LIGHTING FOR NDCT

Aviation obstruction lighting system shall conform to the requirements of the latest applicable rules of International civil aviation organization (ICAO) and NAA/DARA regulations.

The aviation obstruction lighting system shall be of high intensity type. Photo electric controller shall be housed in rugged weather tight, IP 65 enclosure. LED's shall be provided to indicate the operation status of the unit. System controller shall be suitable for operation at specified ambient temperature and shall be wall mounted type. The enclosure shall have IP:55 degree of protection.

Necessary cables for wiring between photocell & system controller and between system controller & obstacle lights shall be provided by vendor.

Vendor shall furnish the complete routine test report of the fixtures, controllers, photocells etc. Testing of aviation lights as per ICAO regulations to be carried out and routine test report to be submitted.

ANNEXURE VIII

CABLE SCHEDULE FORMAT

CABLE SCHEDULE FORMAT **ANNEXURE III**

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

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:
(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

LOAD DATA FORMAT

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.
	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
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)
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.		ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	2X660W TALCHER STAGE-III	NAME		DATA FILLED UP ON
		SYSTEM	NATURAL DRAFT COOLING TOWER	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

TECHNICAL DATA - PART - A (CONTROL & INSTRUMENTATION)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Impulse pipes, tubes (material, rating)		ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
1.2	Valves (material, pr. Class, size)		ASTM A182/ASTM A105 as per ASME 16.34
1.3	Fittings (size, rating, material)		ANSI B31.1, ANSI B31.1a, ASME B16.11
1.4	Installation schemes		BS 6739-2009, ANSI/ISA 77.70
1.5	Fieldbus concepts		IEC 61158
1.6	Instruments and apparatus for pressure measurement		ASME PTC19.2 (1964)
1.7	Bourdon tube pressure and vacuum gauges		IS-3624
1.8	Instrument and apparatus for temperature measurement		ASME PTC 19.3(1974)
1.9	Temperature measurement by electrical Resistance thermometers		IS:2806
1.10	RTD Sensor		IEC-751/ DIN-43760
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	**SPECIFICATIONS - PRESSURE GAUGE**		
2.1.1	Sensing element		Bourdon for high pressure, diaphragm/bellow for low pressure
2.1.2	Sensing element material		SS316
2.1.3	Movement material		SS316
2.1.4	Body material		SS316
2.1.5	Dial size	mm	150mm
2.1.6	End connection	inch	1/2 inch NPT (m)
2.1.7	Accuracy	%	±1% of span
2.1.8	Scale		Linear, 270° arc graduated in metric units
2.1.9	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
2.1.10	Range selection	%	Cover 125% of max. of scale
2.1.11	Diaphragm seal material		Suitable for process fluid
2.1.12	Diaphragm fill fluid		Inert liquid
2.1.13	Wetted parts		All wetted parts upto diaphragm seal shall be suitable for process application
2.1.14	Housing		IP-55
2.1.15	Zero/span adjustment		External
2.1.16	Accessories		Blow out disc, siphon, snubber, pulsation, dampener, chemical seal, gauge isolation valve

2.2	**SPECIFICATIONS - LEVEL SWITCH**		
2.2.1	Repeatability	%	+/-0.5% of full range
2.2.2	No. of contacts		2 No.+2NC. SPDT snap action dry contact
2.2.3	Rating of contacts	V, VA	60 V DC, 6 VA
2.2.4	Elect. Connection		Plug in socket.
2.2.5	Set point adjustment		Provided over full range.
2.2.6	Dead band adjustment		Adjustable/ fixed as per requirement of application.
2.2.7	Enclosure		IP-55, metallic housing.
2.2.8	Power Supply	V	24V DC
2.2.9	Sensing Element		Float type, conductivity type, Ultrasonic type as per suitability to the application
2.2.10	Material		316 SS
2.2.11	End connection		Manufacturer standard
2.2.12	Over range/ proof pressure	%	150% of maximum operating pr.
2.2.13	Accessories		All mounting accessories
2.3	**SPECIFICATIONS - TEMPERATURE GAUGE**		
2.3.1	Body Material		Die-cast aluminium
2.3.2	End connection		3/4" NPT (M)
2.3.3	Accuracy	%	± 1% of span
2.3.4	Dial Size	mm	150 mm
2.3.5	Scale		Linear, 270° arc graduated in °C
2.3.6	Range selection	%	Cover 125% of max. of scale
2.3.7	Over range test		Test pr. for the assembly shall be 1.5 to the max. Design pr. At 38°C.
2.3.8	Housing		IP-55
2.3.9	Zero/span adjustment		Required
2.3.10	Accessories		SS Thermowell
2.4	**SPECIFICATIONS - TEMPERATURE TRANSMITTER**		
2.4.1	Transmitter Type		Profibus PA complying to IEC 61158 with EMC compatibility as per EN 61326, Dual input (Trip/Protection), Single Input (other application)
2.4.2	Compatibility		fully compatible with RTDs
2.4.3	Protection Class		IP-67
2.4.4	Display		Integral digital display
2.4.5	Diagonstic feature		self-indicating diagnostics
2.4.6	Operating ambient temperature (with display)	DegC	70 deg C
2.4.7	Operating ambient temperature (without display)	DegC	85 deg C
2.4.8	Electrical Connection	inch	1/2” NPT(F)
2.4.9	Composite Accuracy	%	RTD =<0.25% of 0-250 deg C span

2.4.10	Changeover facility		Bump less changeover to second sensor in case first sensor fails with alarm facility.
2.4.11	Composite accuracy Calculation		Accuracies of temperature transmitter for converting sensor input to output + temperature effect on these accuracies at ambient temperature of 50 deg C (based on the figure/ formula given in the standard product catalogue for span as specified for RTD).
2.4.12	Emergency/failure Measures		In case of failure (open or burn-out) of RTD, transmitter shall provide low temperature output.
2.5	**SPECIFICATIONS - RESISTANCE TEMPERATURE DETECTOR (RTD)**		
2.5.1	Type		Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.5.2	No. of element		Duplex
2.5.3	Housing		Diecast Aluminium
2.5.4	Protection Class		IP-65
2.5.5	Head		Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter
2.5.6	Plug in connectors		Required
2.5.7	Terminal head		Spring loaded for positive contacts with the thermo well
2.5.8	Insulation and sheathing		Mineral (magnesium oxide) insulation and SS316 sheath
2.5.9	Calibration and accuracy		As per IEC-751/ DIN-43760 Class-A for RTD
2.5.10	Accessories		Thermo well and associated fittings
2.6	**SPECIFICATIONS - THERMOWELL**		
2.6.1	Design		One piece solid bored type of step-less tapered design
2.6.2	Material		SS316
2.7	**SPECIFICATIONS - WIND SPEED SENSOR**		
2.7.1	Principle		Frequency proportional to wind speed
2.7.2	Range	m/sec	0-60 m/ sec
2.7.3	Accuracy	%	2 % of full scale
2.7.4	Threshold	m/sec	0.3 m/ sec
2.7.5	Operating Temperature	DegC	0 to 50 deg C
2.8	**SPECIFICATIONS - WIND DIRECTION SENSOR**		
2.8.1	Principle		Potentiometric type Sensor proportional to Wind direction
2.8.2	Range	Degree	0-360 degree

2.8.3	Accuracy	%	2 % of full scale
2.8.4	Threshold	m/sec	0.3 m/ sec
2.8.5	Operating Temperature	DegC	0 to 50 deg C
2.9	**SPECIFICATIONS - LIMIT SWITCH**		
2.9.1	Operating voltage Range		10-40 V DC
2.9.2	Sensing system		Inductive Proximity type , 2 Wire
2.9.3	Sensor Contact Type		NO
2.9.4	Reverse polarity and short circuit protection		Yes
2.9.5	IP Class-Sensor		IP67
2.9.6	IP Class-Enclosure(Switch box)		IP67
2.9.7	Cable entry-Enclosure(Switch box)		2 no-1/2" NPT
2.9.8	Casing material-Sensor		Brass /SS
2.9.9	Enclosure(Switch box) Housing material		FRP or SS
2.9.10	Operating Ambient temp(sensors)	DegC	-5 to 70 deg C
2.9.11	Max allowed Voltage Drop across sensor	V	5 V
2.9.12	Standard applicable		EN 60947-5-2 or equivalent.
2.9.13	Applicable for		Manual valves and solenoid operated on-off valves
2.9.14	Corrosion resistance		Silver plated with high conductivity and non corrosive
2.9.15	Protection class		IP 55
2.9.16	Contact rating		shall be sufficient to meet the requirement of DCS subject to a minimum of 60 V, 6 VA rating
2.10	**SPECIFICATIONS - JUNCTION BOX**		
2.10.1	No. of ways		12/24/36/48/64/72/96/128
2.10.2	Material and Thickness		4mm thick Fiberglass Reinforced Polyester (FRP)
2.10.3	Type of terminal blocks		Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm2. A M6 earthing stud shall be provided.
2.10.4	Protection Class		IP- 55 min. for indoor & IP-65 min for outdoor applications.
2.10.5	Grounding		To be provided
2.10.6	Color		RAL 7035
2.10.7	Spare Terminals		At least 20% unused terminals
2.11	**Impulse piping for water area/equipment**		
2.11.1	Painting color scheme		Grey RAL 9002
2.11.2	Identification Tag/band color scheme		Sea green, ISC no. 217
2.12	**Temperature Switch**		

2.12.1	Sensing Element		Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (5 m minimum, to suit application) 61158, digital output
2.12.2	Material		Bulb 316 SS/ capillary 304 SS
2.12.3	End connection		½ inch NPT (F)
2.12.4	Repeatability		+/- 0.5% of full range
2.12.5	No. of contacts		2 No.+2NC. SPDT snap action dry contact
2.12.6	Rating of contacts		60 V DC, 6 VA (or more if required by DDCMIS)
2.12.7	Elect. Connection		Plug in socket.
2.12.8	Set point adjustment		Provided over full range.
2.12.9	Dead band adjustment		Adjustable/ fixed as per requirement of application.
2.12.10	Enclosure		Weather and dust proof as per IP-55, metallic housing
2.12.11	Accessories		Thermo well of 316 SS and packing glands
2.12.12	Mounting		Suitable for rack mounting or direct mounting
Notes:	1) Where 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) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.		
2.13	**DATASHEET - LOCAL CONTROL PANEL**		
2.13.1	**Construction**		
	Type		Skid mounted
	Construction		Folded
	Devices & equipments		Panel enclosure, secondary instruments, annuniciation system, selector switch, push buttons, indicating lamps/ led cluster, relays, MCBs, clamp on terminals, plug socket, panel light, space heater, nameplate, earth bus
	Enclosure sheet material		Cold rolled sheet steel
	Enclosure sheet thickness		Minimum 3.0 mm for load bearing sections (mounted with instruments)
			2.0 mm for doors
			Minimum 2.0 mm for other sections
	Height		Minimum 1100 mm
	Frame thickness		Minimum 3.0 mm
	Internal plate thickness		2.5 mm
	Gland plate thickness		3.0 mm
	Cable gland		Double compression
	Base channel		ISMC 100 with anti-vibration mounting & foundation bolts
	Class of protection		IP-55
2.13.2	**Doors**		

	Rear doors		Required with integral lockable handle
	Door locking		Door when locked shall be held at minimum three places.
	Type		Removable type with concealed hinges to facilitate maintenance work
	Suitable pocket inside the door		Required for keeping the drawings / documents
	Double door		Required with suitable glass windows as per the requirement.
2.13.3	**Power & control supply**		
	Input power supply		415V 3 phase AC
	No. Of feeders		Two
	Control supply		230v ac
	Additonal requirement for control supply		MCBs
			Supervisory relay along with a pilot lamp to indicate control supply 'on'
			Auto changeover unit mounted on panel
2.13.4	**Internal wiring**		
	Voltage		1100 V
	Material & size		PVC insulated copper multi strand wire /flexible of 1.5mm2, power cable 2.5sqmm
	Routing and runs		Through PVC troughs, AC & DC wires shall be kept separately
	Colour		Separate colours for AC & DC wires
	Ferruling		Cross ferruling
2.13.5	**Painting details***		
	Painting shade & thickness - exterior / interior (these details shall be finalised during		RAL 5012 & minimum 85 microns / glossy white & minimum 70 microns
2.13.6	**Gasket**		
	At door & removable cover		Neoprene
2.13.7	**Ventilation system along with louvers**		
	Cooling fan		2 x 100%, covered with removable wire mesh
2.13.8	**Terminal block**		
	Type		Clip on, separate for AC & DC circuits
	Voltage		1100 V
	Tb points		Cage clamp
	Mounting height from finished floor		>=250 mm
	Spare		20%
	Identification strip		To be provided
2.13.9	**Illumination**		
	Light		Led tubelight
	Shrouded cover	W	15W minimum
	Operating power supply		240V 50 Hz AC
	Operable through		Panel door switch
	Power receptacle		15 Amp, 3-pin
2.13.10	**Earthing studs**		

	Termination to main station earth		Internally with 10 mm bolts at extreme ends for connection
2.13.11	**Alarm annunciator system**		
	No. Of windows	Nos.	Minimum 20
	Facia		Solid state discrete
	Hooter		10W
	Annunciator spare (with electronics)		10% spare window or minimum 2nos. Whichever is more
	Lamp test provision		Required
2.13.12	**Mounting devices on panel**		
	On front side		All operable and indicating devices
	Inside panel		Aux. Relays, terminal, PVC trough, MCBs etc.
	Easy access for operation / maintenance.		Required

TECHNICAL DATA - PART - B (MECHANICAL)
(SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	Type Model No. (Single air inlet, Double air inlet)		
2.0	Quantity	Nos/ Unit	
3.0	Rated Capacity	M^3/Hr	
4.0	Ambient Design Wet Bulb Temperature	°C	
5.0	Recirculation Allowance	°C	
6.0	Design Inlet Wet Bulb Temp (including recirculation allowance)	°C	
7.0	Cold Water Temperature	°C	
8.0	Cooling Tower Approach	°C	
9.0	Cooling Tower Range	°C	
10.0	Cooling Tower Loss		
10.1	Evaporation Loss		
10.2	Drift Loss		
10.3	Blow Down Loss (Concentration Factor to be indicated)		
11.0	Basin Storage capacity	M3/hr	
12.0	Plan Dimensions (Diameter)	M	
13.0	Overall Size of Cooling Tower (Plan Dimensions X Height)	M x M	
14.0	Required Pumping Head including all losses measured from basin, curb level	M	
15.0	Cooling Tower Levels		
15.1	Graded Level	M	
15.2	Maximum Water Level	M	
15.3	Basin Curb Level	M	
15.4	Minimum Water Level	M	
15.5	Basin Bottom Level	M	
16.0	Overall Tower Height from Basin Floor	M	
17.0	Basin Dimensions		
17.1	Diameter	M	
17.2	Depth (from basin curb)	M	
18.0	Free Board (Above Max. Water Level)	mm	
19.0	Heat Transfer Data		
19.1	Heat Transfer Coefficient (K)		
19.2	Tower Coefficient © Ka V/L	M	
19.3	Average Fill Height	M	
19.4	Total Fill Volume	Cub M	
19.5	Total Water wetted surface	Sq M	
19.6	Total Tower Wetted Surface	Sq M	
20.0	Hot Water Distribution Piping		

20.1	Size (OD X Thk)	mm x mm	
20.2	Elevation of Center Line of Hot Water distribution Header	M	
20.3	Design pressure for Hot Water Distribution System	Kg/cm2 (g)	
21.0	Isolation Valves in Hot Water Risers (As applicable)		
21.1	Size	mm	
21.2	Quantity	Nos./ cell	
21.3	Type/Code & Standard		
21.4	Make		
21.5	Pressure drop across the valve in fully open position	MWC	
21.6	Materials of Construction		
21.6.1	Body		
21.6.2	Disc		
21.6.3	Drive Shaft/Stub Shaft		
21.6.4	Bearings		
21.7	Test Pressure / duration	Kg/cm2 (g) / Min.	
22.0	Flow Control Valves (If Applicable)		
22.1	Make		
22.2	Size	mm	
22.3	No. of Cell	Nos	
22.4	Materials of Construction		
22.4.1	Body		
22.4.2	Spindle		
22.4.3	Trim		
23.0	**Isolating Valve in Sludge Pit**		
23.1	Size	mm	
23.2	Quantity	Nos / CT	
23.3	Type		
23.4	Make		
23.5	Conform to which code in respect of design/testing		
23.6	Materials of Construction		
23.6.1	Body		
23.6.2	Stem		
23.6.3	Trim		
24.0	**Stationary Screen**		
24.1	Quantity	Nos / CT	
24.2	Size & Material of Bar		
24.3	Clear Space between the bar		
24.4	Lifting Arrangement		
25.0	**Fill & Fill Supports**		
25.1	Type of fill		
25.2	Material		

25.3	Type of treatment (in case of timber fill)		
25.4	Expected Life	Years	
25.5	Arrangement of Fill/splash bars (horizontal etc.)		
25.6	Method to prevent dislocation of Fills		
25.7	Type/Material/Size of fixing arrangement to supporting grid		
25.8	Fill Support Grids		
25.8.1	Type		
25.8.2	Material (give full specification)		
25.8.3	Size		
25.8.4	Colour of Fill		
25.9	Grid Supporting Frames		
25.9.1	Type		
25.9.2	Material (give full specification)		
25.9.3	Size		
25.10	Fasteners		
25.10.1	Type		
25.10.2	Fill		
25.10.3	Fill Support Grids		
25.10.4	Frames for Supporting the Grids		
26.0	Drift Eliminators		
26.1	Number of Passes		
26.2	Gross Face Area per pass	Sq M	
26.3	Type		
26.4	Eliminator Blades		
26.4.1	Material		
26.4.2	Maximum Length of blade	mm	
26.4.3	Size and shape of blades		
26.4.4	Type and material of drain boards		
26.5	Blade Support Spacers		
26.5.1	Type		
26.5.2	Material		
27.0	**Gate in Cold Water Outlet Channel**		
27.1	Number per cold water outlet channel		
27.2	Gate Type		
27.3	Name of Manufacturer		
27.4	Gate Size		
27.5	Weight of each gate	Kg	
27.6	Are elements of gate dismantling type?		
27.7	Weight of each Element	Kg	
27.8	Frame Type		
27.9	Fixing arrangement of frame with RCC channel		
28.0	**Lifting Arrangement of Gate**		

28.1	Type of treatment for the wood (in case of wooden gates)		
28.2	Expected Life	Years	
29.0	**VERTICAL SLUDGE PUMP & MOTOR (Optional Item)**		
29.1	Vertical sludge pumps complete with electric motors, valves, piping and fittings at their discharge offered.	Yes / No	
29.2	Make & Model No.		
29.3	Rated capacity	M3/Hr	
29.4	TDH	MWC	
29.5	Pump speed	RPM	
29.6	Pump efficiency	%	
29.7	Power consumption at rated flow	KW	
29.8	Motor HP provided	HP / KW	
29.9	Material of Construction		
29.9.1	Impeller		
29.9.2	Casing		
29.9.3	Pump & Line Shaft		
29.9.4	Bearings		
29.9.5	Impeller/Casing Wearing Rings		
30.0	Cooling Tower Materials of Construction		
30.1	Casing		
30.2	Louvers		
30.3	Cell Partition Walls		
30.4	Basin Partition Walls		
30.5	Stack		
30.6	Stair Case		
30.7	Hot Water piping		
30.8	Hot Water distribution basin		
30.9	Internal Walkways		
30.10	Supporting Structure		
30.11	Hand Rails		
30.12	Structure Connector		
30.13	Bolts, nuts, washers and other hardware		
30.14	Nails		
30.15	Anchor Bolts		
30.16	Hot Water Distribution Nozzle		
30.17	Hot Water distribution Plates		
30.18	Spacers		
30.19	Mechanical Equipment Support		
31.0	Weight of Equipments		
31.1	Weight of Heaviest part to be handled	Kg	
31.2	Size of largest part to be handled		

32.0	Inspection & Testing		
32.1	Hydro Test Pressure for Hot water piping		
32.1.1	Test Pressure	Kg/cm2 (g)	
32.1.2	Duration	Minutes	
32.2	Field performance test for the tower shall be conducted.	Yes / No	
33.0	Cooling Water Flow Rate (L)	$Kg/m^2/Hr$	
34.0	Dry Air Flow Rate (G)	$Kg/m^2/Hr$	
35.0	Ratio of Water to Air	(L/G)	
36.0	Dry Air Flow	Kg/Hr	
37.0	Temperature of air leaving the Stack	°C	
38.0	Inlet air Enthalpy	KCal/Kg	
39.0	Exit air Enthalpy	KCal/Kg	
40.0	Total Heat Exchange/Kg of Inlet Dry air	KCal/Kg	
41.0	Losses in hot water piping	MWC	
42.0	Type of air inlet	MWC	
43.0	Pressure recovery from fan stack	mm	
44.0	Air inlet are per cell	Max.	
45.0	Splash surface of fill per cell	M^2	

TECHNICAL DATA - PART - B (SUPPLIER DATA TO BE FURNISHED AFTER AWARD OF CONTRACT)

SL.NO	DESCRIPTION	UOM	DETAIL
	FOLLOWING DATA SHALL BE FILLED UP BY VENDOR FOR EACH INSTRUMENT (RTD, THERMOWELL ETC.)		
1.0	MAKE		
1.1	MODEL		
1.2	TAG NO. / KKS NO.		
1.3	SERVICE		
1.4	QUANTITY		
1.5	OPERATING PRESSURE		
1.6	OPERATING TEMPERATURE		
1.7	DESIGN PRESSURE		
1.8	DESIGN TEMPERATURE		
1.9	RANGE		

COMPLIANCE DRAWING

A) WATER ANALYSIS (ANNEXURE-I)
B) DETAILS OF CT OUTLET (ANNEXURE-II)
C) COORDINATES AND BATTERY LIMIT OF NDCT (ANNEXURE-III)
D) C&I DRAWINGS (ANNEXURE-IV)

PROJECT INFORMATION

CIRCULATING COOLING WATER WITH 5 COC

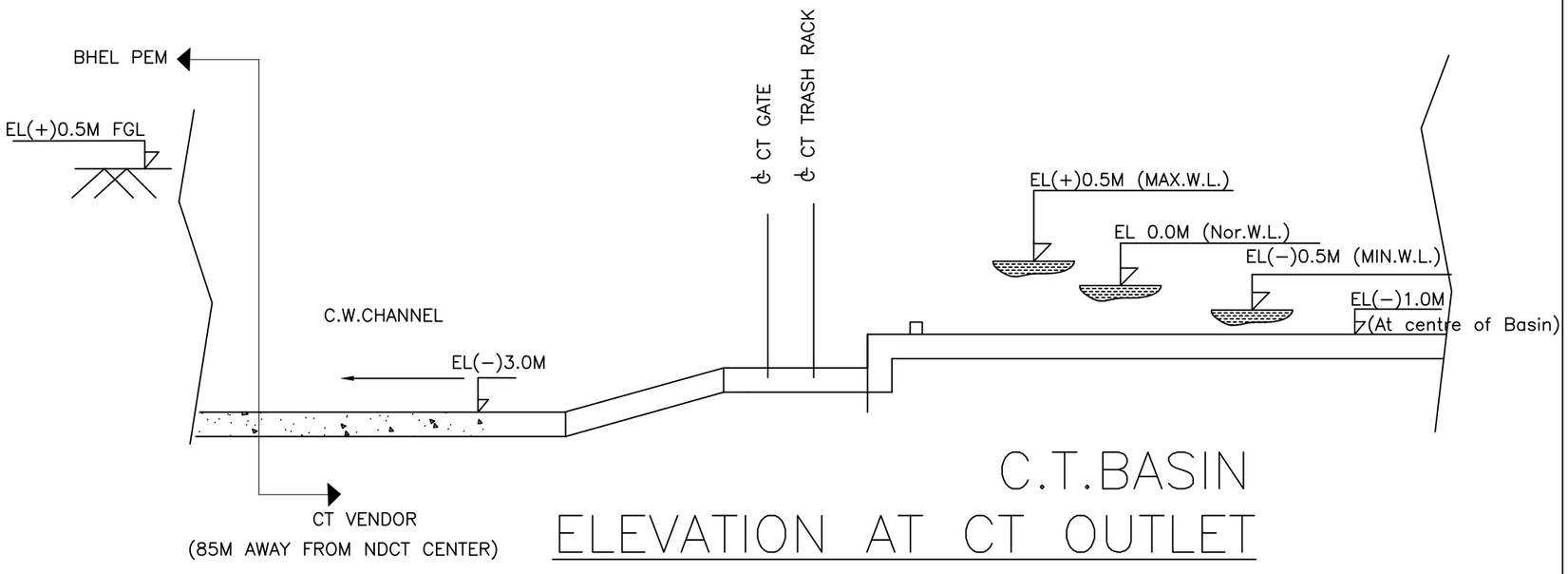
COC=5

Sl No.	Parameters	Unit	Results
1	pH		6.5-8.0
2	Turbidity	NTU	50
3	P-Alkalinity	mg/l as $CaCO_3$	
4	M-Alkalinity	mg/l as $CaCO_3$	150
5	Calcium	mg/l as $CaCO_3$	285
6	Magnesium	mg/l as $CaCO_3$	135
7	Chloride	mg/l as Cl	70
8	Sulphate	mg/l as SO_4	80
9	Colloidal Silica	mg/l as SiO_2	NA
10	Reactive Silica	mg/l as SiO_2	80
11	Sodium + Potassium	mg/l	95
12	Total Organic Carbon (TOC)	mg/l	20
13	Chemical Oxygen Demand (COD)	mg/l	30
14	Biological Oxygen Demand (BOD)	mg/l	5
15	Equivalent Mineral Acid (EMA)	mg/l	135
16	Total Suspended Solids (TSS)	mg/l	50
17	Total Iron	mg/l as Fe	2.5
18	$KMnO_4$ No	mg/l	16-50
19	Dissolved Oxygen (DO)	mg/l	6-8
20	Sp Conductivity	(micro siemens/cm)	1100
21	TDS	mg/l	750
22	TOTAL ANIONS	mg/l	515
23	TOTAL CATIONS	mg/l	515
24	Temperature	Deg C	18-36

EL(+)0.0M CORRESPONDS TO RL 305.5M

ANNEXURE–II

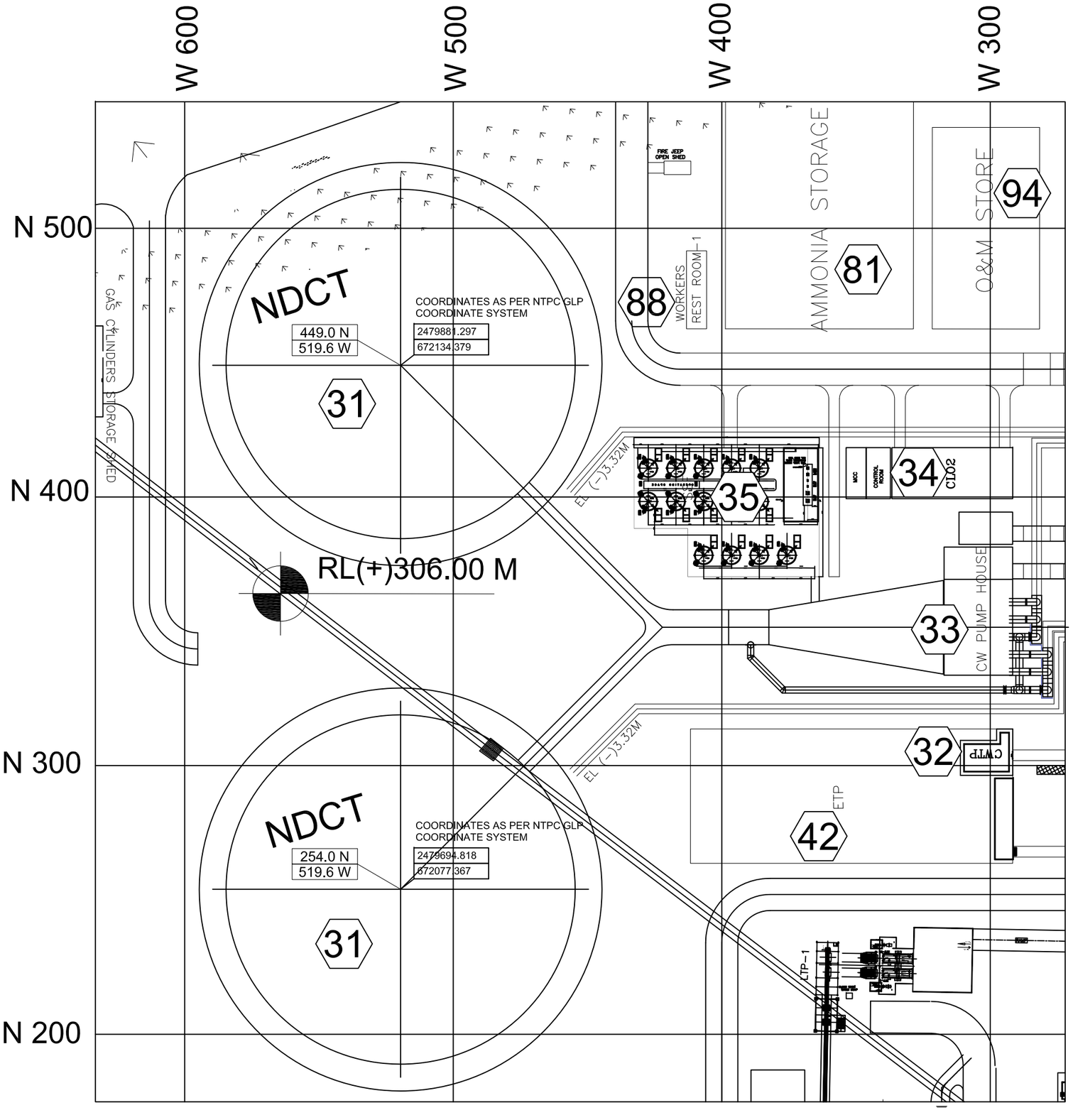
COOLING WATER CHANNEL

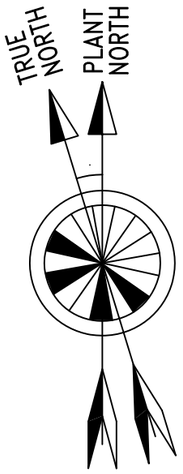


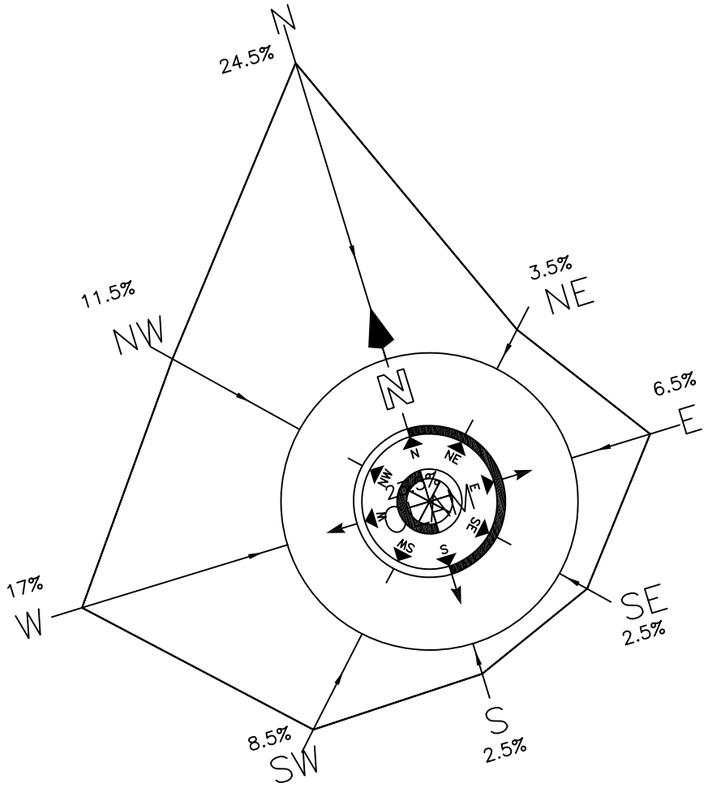
C.T.BASIN

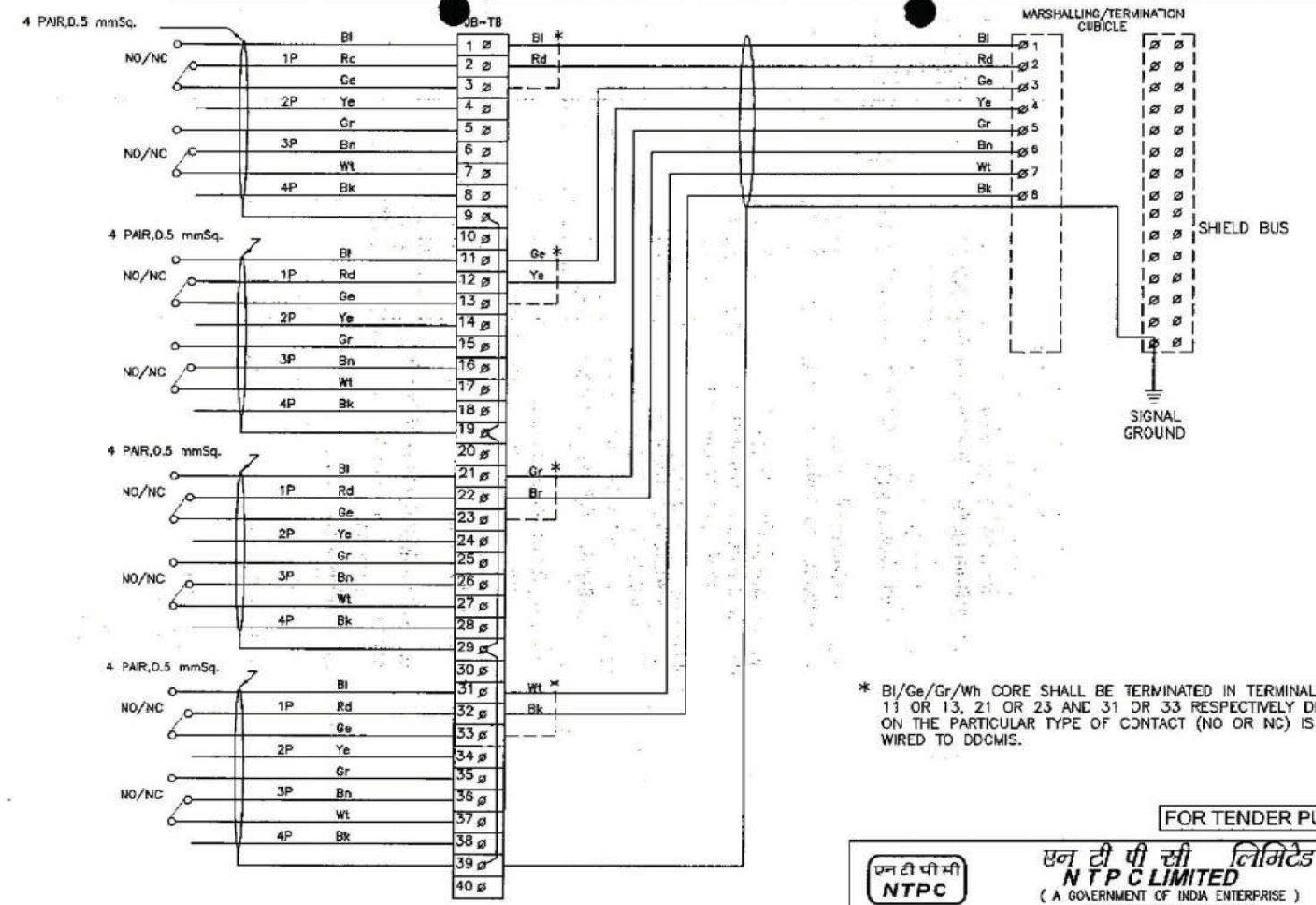
ELEVATION AT CT OUTLET

ANNEXURE–III









FOR TENDER PURPOSE ONLY

एन टी पी सी लिमिटेड
NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

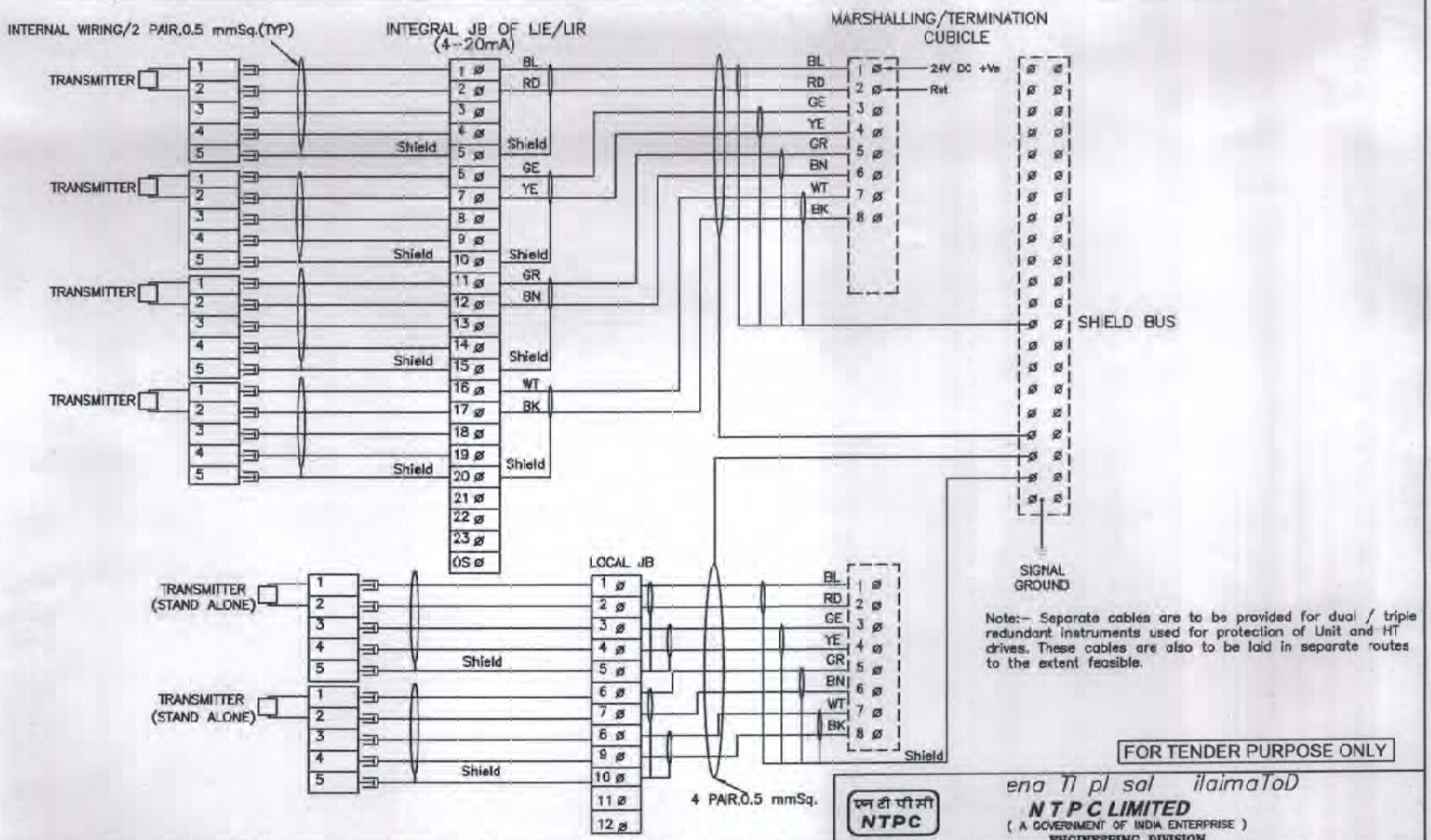
PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS SWITCH TERMINATION DETAILS NO/NC

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE										29.04.06

CLEARED BY

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 02 OF 14	A



Note:- Separate cables are to be provided for dual / triple redundant instruments used for protection of Unit and HT drives. These cables are also to be laid in separate routes to the extent feasible.

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NTPC LIMITED
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ENGINEERING DIVISION

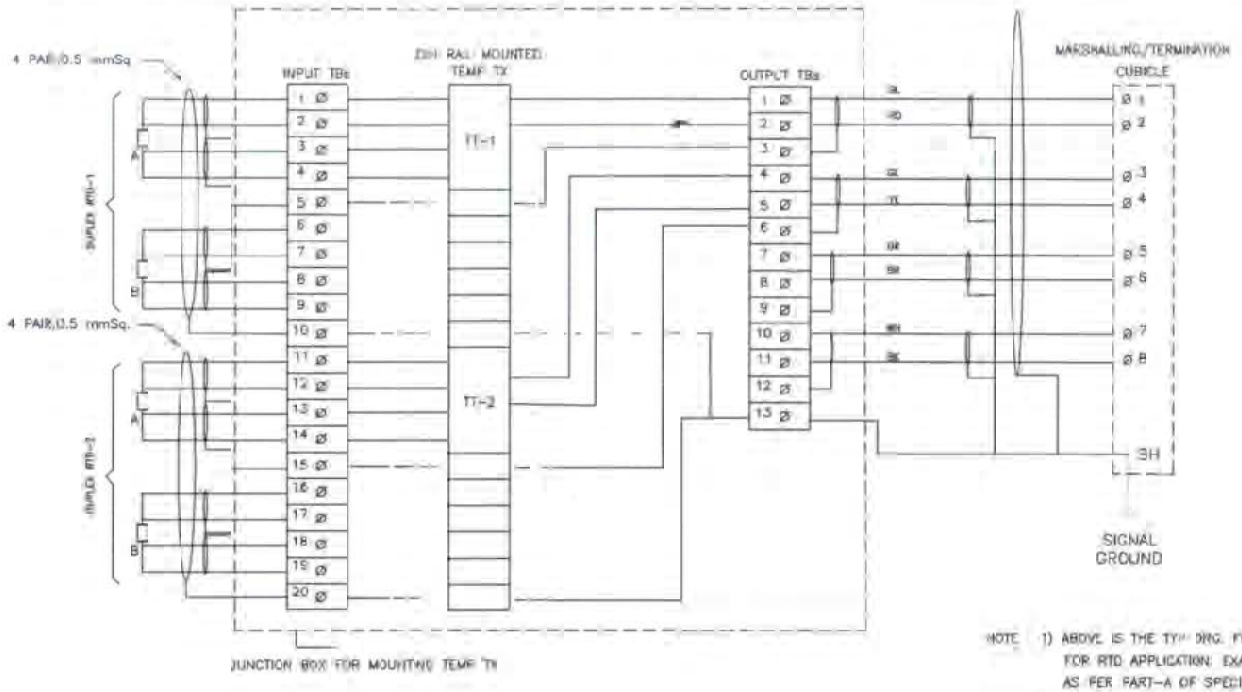
REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
C	NOTE REGARDING CABLE IS ADDED.										10.12.13
B	INTERNAL WIRING FOR LIE/LIR MOUNTED SHOWN WIRING OF STAND ALONE TXTR SHOWN										10.12.06
A	FIRST ISSUE										12.1.05

CLEARED BY

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS 4-20mA

SIZE	SCALE	DRG. NO.	REV. NO.
A3	NTS	0000-999-POI-A-065 SH 04 OF 14	C



NOTE: 1) ABOVE IS THE TYP. DRG. FOR DIN RAIL MOUNTED TEMP. TRANSMITTERS FOR RTD APPLICATION. EXACT TYPE OF TEMP. TRANSMITTER SHALL BE AS PER PART-A OF SPECIFICATION.
2) THE EXACT GROUPING OF TEMP TXs SHALL BE FINALISED DURING DETAILED ENGG. STAGE.

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N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

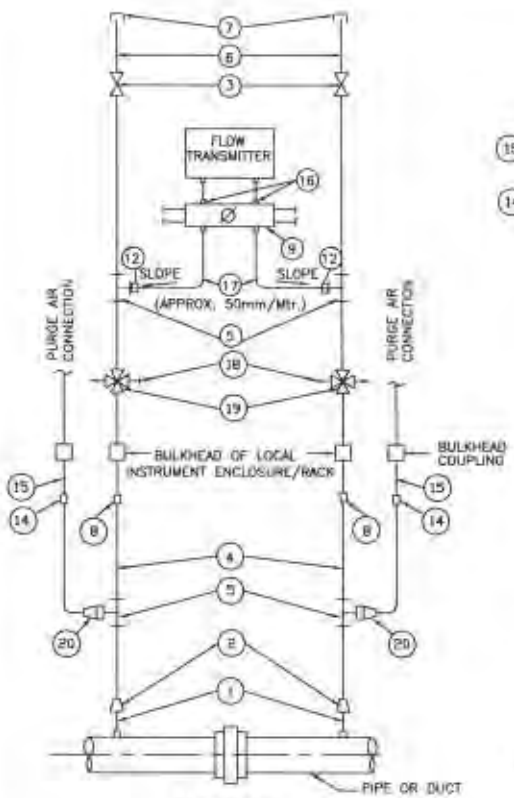
PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INTERFACING OF FIELD INSTRUMENTS
TYPICAL RTD CONNECTION WITH TEMP TRANSMITTERS INJBs

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE									29.04.06

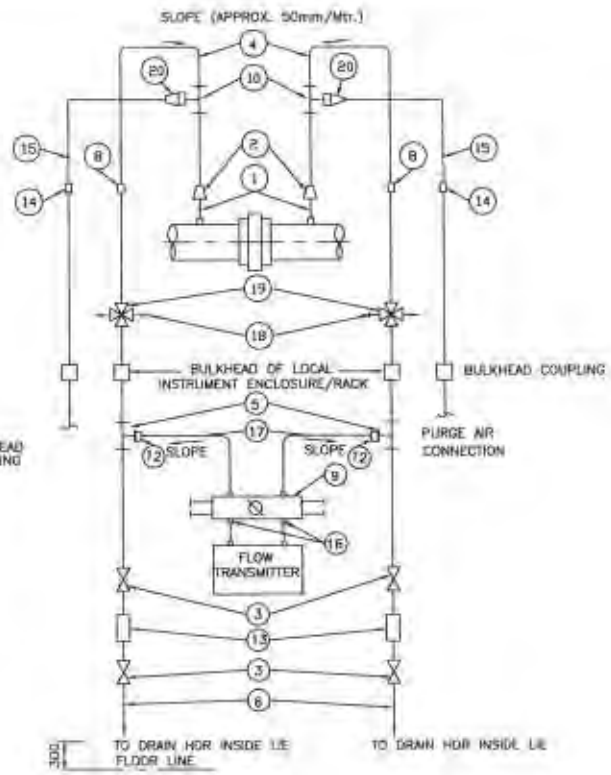
CLEARED BY

SIZE	SCALE	DRG. NO.	REV. NO
A3	NTS	0000-999-POI-A-065 SH 01 OF 14	C



ELEVATION

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT



ELEVATION

TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT

LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	42x4.05mm M.S. BLACK PIPE.
2.	M 42x2 TO 3/4"SW REDUCING INSERT.
3.	3/4" SW GLOBE VALVE.
4.	3/4" PIPE.
5.	3/4" SW EQUAL TEE.
6.	3/4" SCH. 80 SWx3/4" NPT (M) CS/AS NIPPLE.
7.	3/4" NPT (F) CAP.
8.	3/4" PIPE UNION.
9.	5 VALVE MANIFOLD FOR DETAIL REFER DRAWING NO.0000-102-POI-A-026.
10.	3/4" SW EQUAL TEE.
11.	3/4" SW GATE VALVE.
12.	3/4" PIPE x 1/2" TUBE UNION.
13.	DRAIN POT.
14.	1/2" GI FITTING.
15.	1/2" NB GI PIPE.
16.	SUITABLE ADAPTER.
17.	SS TUBE.
18.	QUICK DISCONNECT FITTINGS.
19.	3/4" SW 4 WAY VALVE.
20.	3/4" x1/2" REDUCER.

NOTES:-

1. SAME NOTES AS UNDER DRG. NO. 0000-999-POI-A-023.

FOR TENDER PURPOSE ONLY

AIR/GAS FLOW MEASUREMENT USING HEAD TYPE PRIMARY ELEMENT

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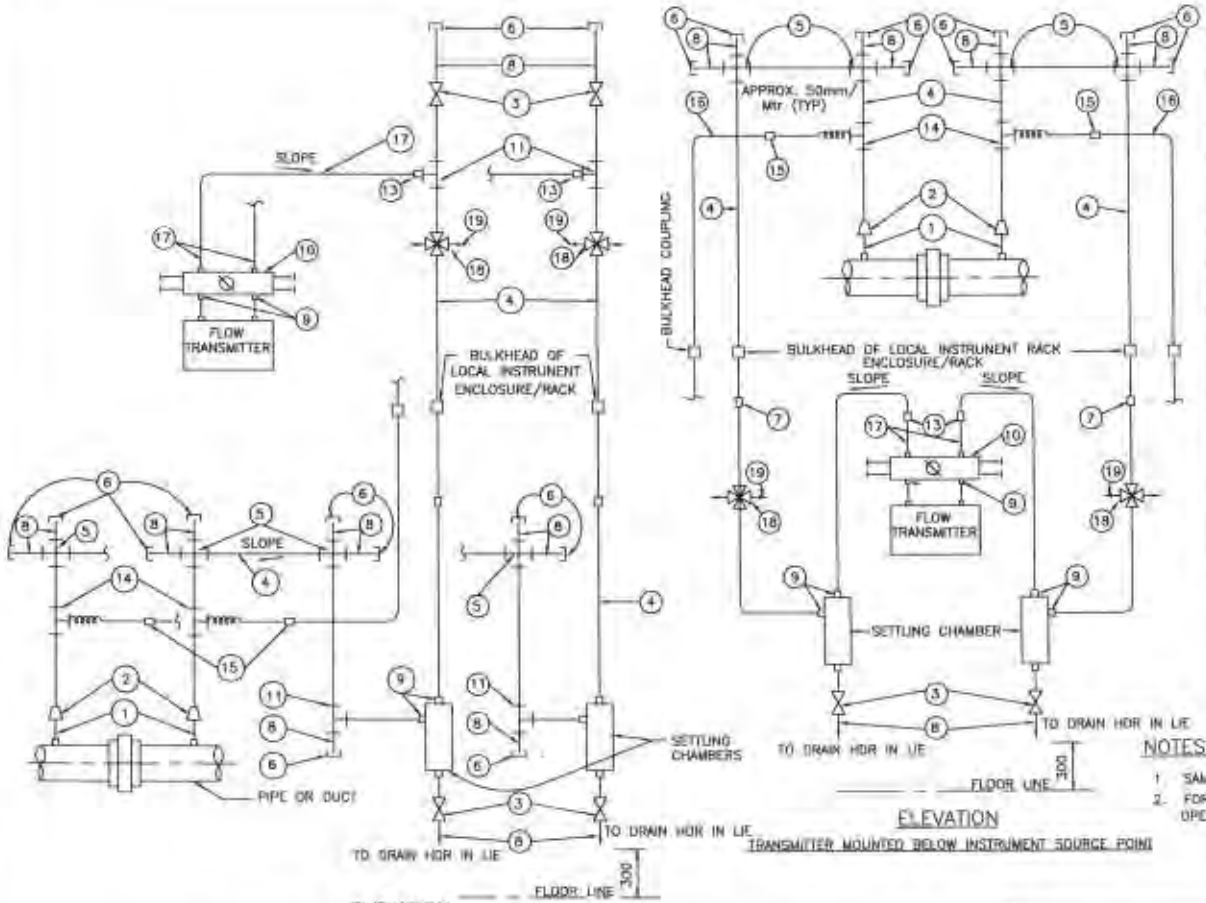
N T P C LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INSTRUMENT INSTALLATION DIAGRAM (FLOW MEASUREMENT AIR/GAS)

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD	DATE
A	FIRST ISSUE							T.G.			21.08.12
					CLEARED BY						

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-028	B



LIST OF MATERIALS

ITEM NO.	DESCRIPTION
1.	42x4.05mm M.S. BLACK PIPE.
2.	M 42x2 TO 3/4"SW REDUCING INSERT.
3.	3/4" SW GLOBE VALVE.
4.	3/4" NPS PIPE.
5.	3/4" SW EQUAL CROSS.
6.	3/4" NPT (F) CS/AS CAP.
7.	3/4" PIPE UNION.
8.	3/4" NPS SWx3/4" NPT (M) CS/AS NIPPLE
9.	SUITABLE ADAPTER
10.	5 VALVE MANIFOLD FOR DETAIL REFER DRAWING NO.0000-999-POI-A-026.
11.	3/4" SW EQUAL TEE.
12.	3/4" SW GATE VALVE.
13.	3/4" PIPE x 1/2" TUBE UNION
14.	3/4" SW x 1/2" SW BRANCH TEE.
15.	1/2" GI FITTING
16.	1/2" NB GI PIPE.
17.	SS TUBE
18.	3/4" SW 4 WAY VALVE.
19.	QUICK DISCONNECT FITTINGS.

NOTES:-

1. SAME NOTES UNDER DRG. NO. 0000-999-POI-A-023.
2. FOR VACUUM APPLICATION OTHER PORT OF TRANSMITTER SHALL BE KEPT OPEN TO ATMOSPHERE.

FOR TENDER PURPOSE ONLY

DIRTY AIR/FLUE GAS FLOW MEASUREMENT USING HEAD TYPE PRIMARY ELEMENT

NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

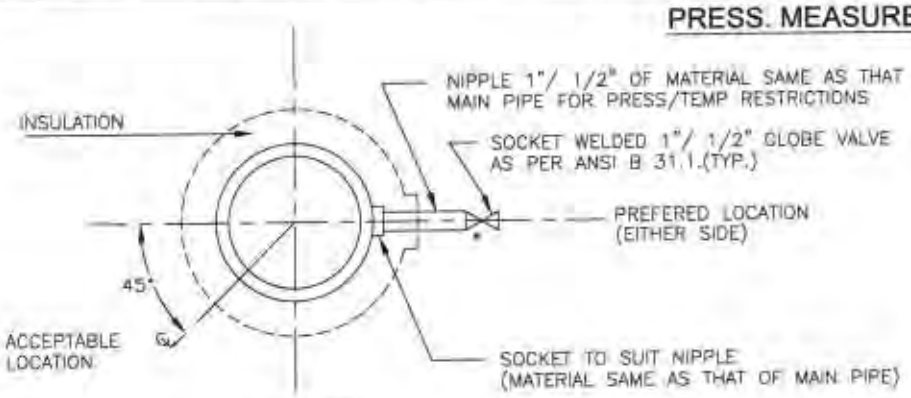
TITLE: INSTRUMENT INSTALLATION DIAGRAM (FLOW MEASUREMENT DIRTY AIR/ FLUE GAS)

REV NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH	APPD	DATE
A	FIRST ISSUE							T.G.			21.08.12

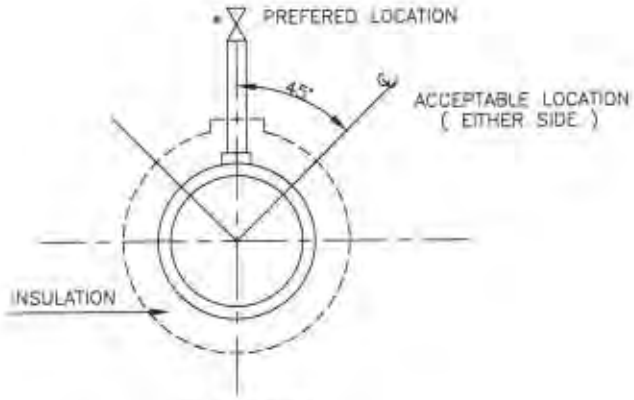
CLEARED BY

SIZE	SCALE	DRG. NO.	REV. NO.
A3	N.T.S.	0000-999-POI-A-029	A

PRESS. MEASUREMENT

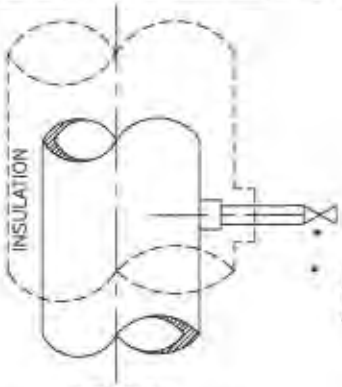


ELEVATION
LIQUID SERVICE



ELEVATION
STEAM SERVICE

PRESSURE CONNECTION ON HORIZONTAL PIPE



ELEVATION
LIQUID OR STEAM SERVICE

PRESSURE CONNECTIONS ON VERTICAL PIPES

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NTPC LIMITED
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ENGINEERING DIVISION

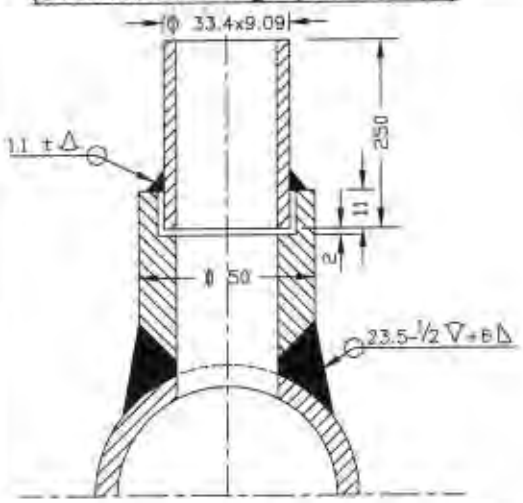
REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE							T.C.			

CLEARED BY

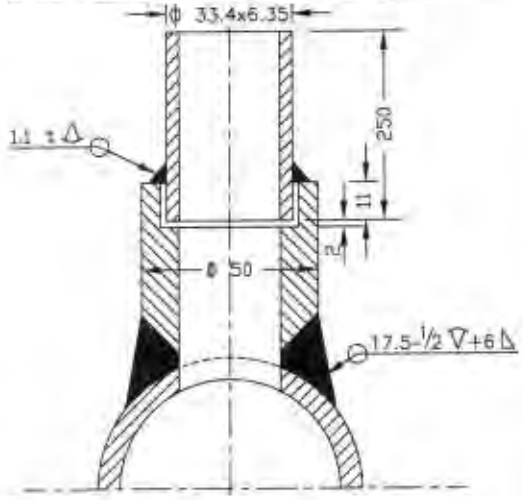
PROJECT	TYPICALTHERMAL POWER PROJECT
TITLE	INSTRUMENT SOURCE CONNECTION DETAILS
SIZE	A4
SCALE	N.T.S.
DRG. NO.	0000-999-POI-A-035 SH-1 OF 1A
REV. NO.	A

PRESSURE MEASUREMENT

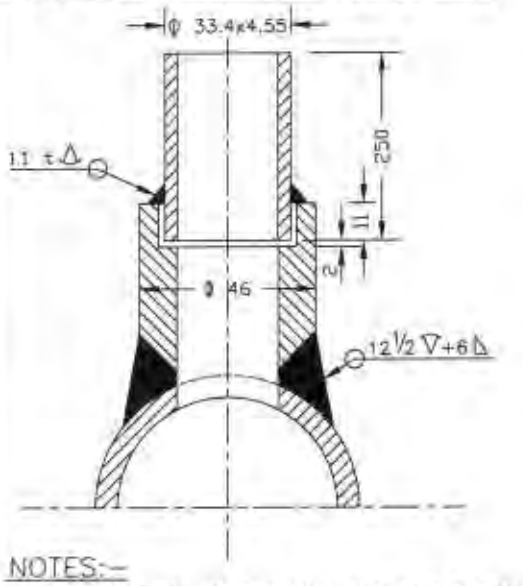
(SYSTEM PR.>40Kg/Sq Cm CL 9000)



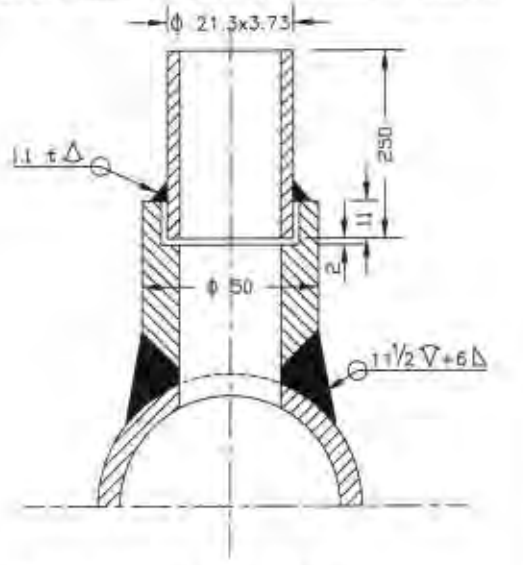
(SYSTEM PR.>40Kg/Sq Cm CL 6000)



(SYSTEM PR. <40Kg/Sq cm Nb 25 CL 3000)



(SYSTEM PR. <40Kg/Sq cm Nb 15 CL 3000)



NOTES:-

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFIRM TO ANSI B 16.11.
2. THE LENGTH OF THE NIPPLE SHOULD BE 250mm.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 16.1.
4. TWO ISOLATED VALVES ARE TO BE USED FOR PRESSURE = >40 Kg/Cm2.
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.
6. ORIENTATION OF TAP WILL BE VARY WITH TYPE OF PROCESS FLUID AND NATURE OF RUN OF THE PIPE.
7. ACTIVITIES TO BE COMPLETED AT THE SHOP, WELD THE COUPLING (OR BOSS) ON THE PIPE AND DRILL PRESSURE CONNECTION HOLE (SAME AS I.D OF NIPPLE) IN THE PIPE IN ALLIGNMENT WITH HOLE IN THE COUPLING.
8. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPR.	DATE
A	FIRST ISSUE							Y.G.			

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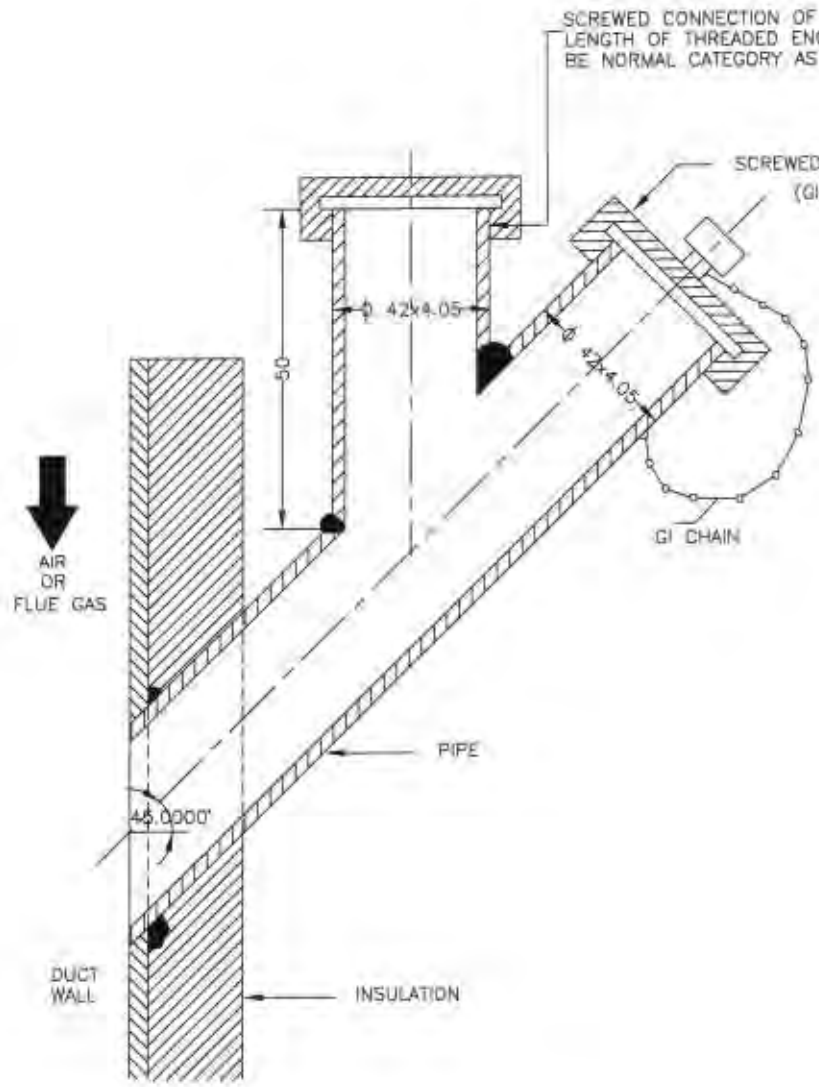
NTPC — NTPC LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-3 OF 14	A

PRESS. MEASUREMENT



NOTES:-

1. THIS TYPE OF PRESSURE CONNECTON SHALL BE PROVIDED FOR PRESSURE MEASUREMENTS IN AIR AND FLUE GAS DUCT/FURNACE.
2. DIMENSIONS ARE INDICATIVE ONLY..

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD	M	E	C	T.O. C&I	ARCH	APPD.	DATE
A	FIRST ISSUE										

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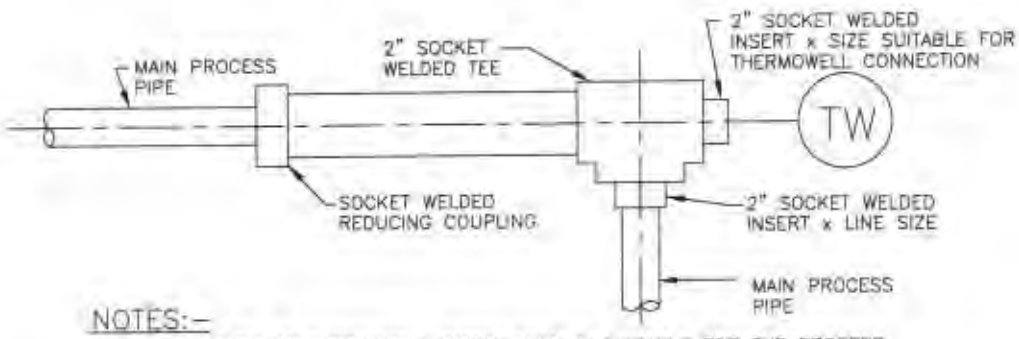
NTPC — N T P C LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

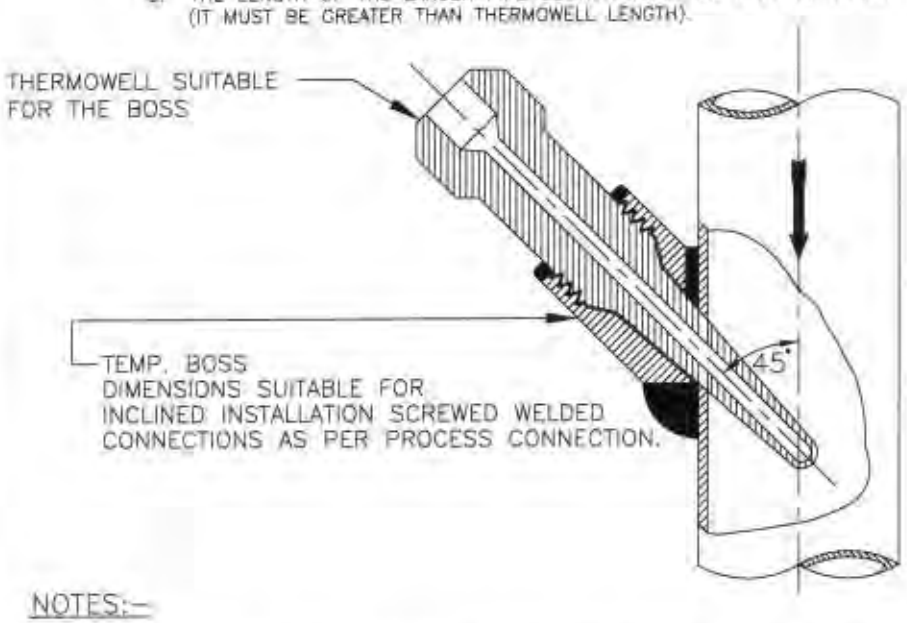
SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 SH-5 OF 14	A

TEMP. MEASUREMENT



NOTES:-

1. THIS TYPE OF THERMOWELL INSTALLATION IS SUITABLE FOR THE PROCESS PIPE OF 2" NPS AND SMALLER.
2. FOR STEAM SERVICE THIS TYPE OF THERMOWELL INSTALLATION 90° BEND MAY BE USED ONLY IN VERTICAL PLANE.
3. THE LENGTH OF THE LARGER PIPE SECTION SHALL BE MINIMUM 150mm (IT MUST BE GREATER THAN THERMOWELL LENGTH).



NOTES:-

1. INCLINED INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MIN. 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF MIN. 3" SIZE OF MAIN PIPING SPECIFICATION SHALL BE USED.
3. THIS TYPE OF INSTALLATION IS APPLICABLE FOR HORIZONTAL AND VERTICAL PIPE SECTION.
4. FOR STEAM SERVICES EXPANDER SECTION MAY BE USED ONLY IN VERTICAL RUN.
5. THE EXPANDER SECTION SHALL BE OF ADEQUATE LENGTH (ATLEAST 3–4 TIMES DIA OF THE MAIN PROCESS PIPE AT BOTH SIDE OF THE INSTALLED THERMOWELL).

FOR TENDER PURPOSE ONLY

NTPC — N T P C LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	S	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE						T.G.				31.JAN.18

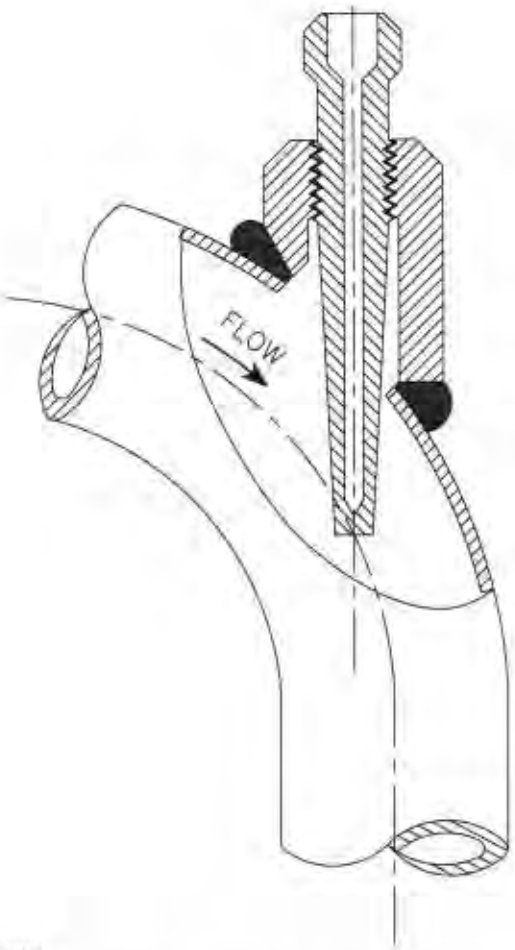
CLEARED BY

PROJECT: TYPICALTHERMAL POWER PROJECT (SG PACKAGE)

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO	REV. NO.
A4	N.T.S.	0000-999/102-POI-A-035 Sh-4 OF 14	A

TEMP. MEASUREMENT



NOTES:-

1. FLOW INSTALLATION OF THERMOWELL SHALL BE APPLICABLE FOR 4" AND SMALLER LINE SIZE BUT LIMITED TO MINIMUM 3" LINE SIZE.
2. FOR 2" AND SMALLER LINE SIZE NECESSARY EXPANDER OF ELBOW FORM (AS SHOWN) OF MINIMUM 3" SIZE SHALL BE USED.
3. ELBOW EXPANDER SECTION IN HORIZONTAL PLANE MAY BE USED FOR LIQUID SERVICES, ONLY STEAM SERVICES EXPANDER SECTION MAY BE USED IN VERTICAL PLAN.

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH.	APPD.	DATE
A	FIRST ISSUE							T.C.			

CLEARED BY

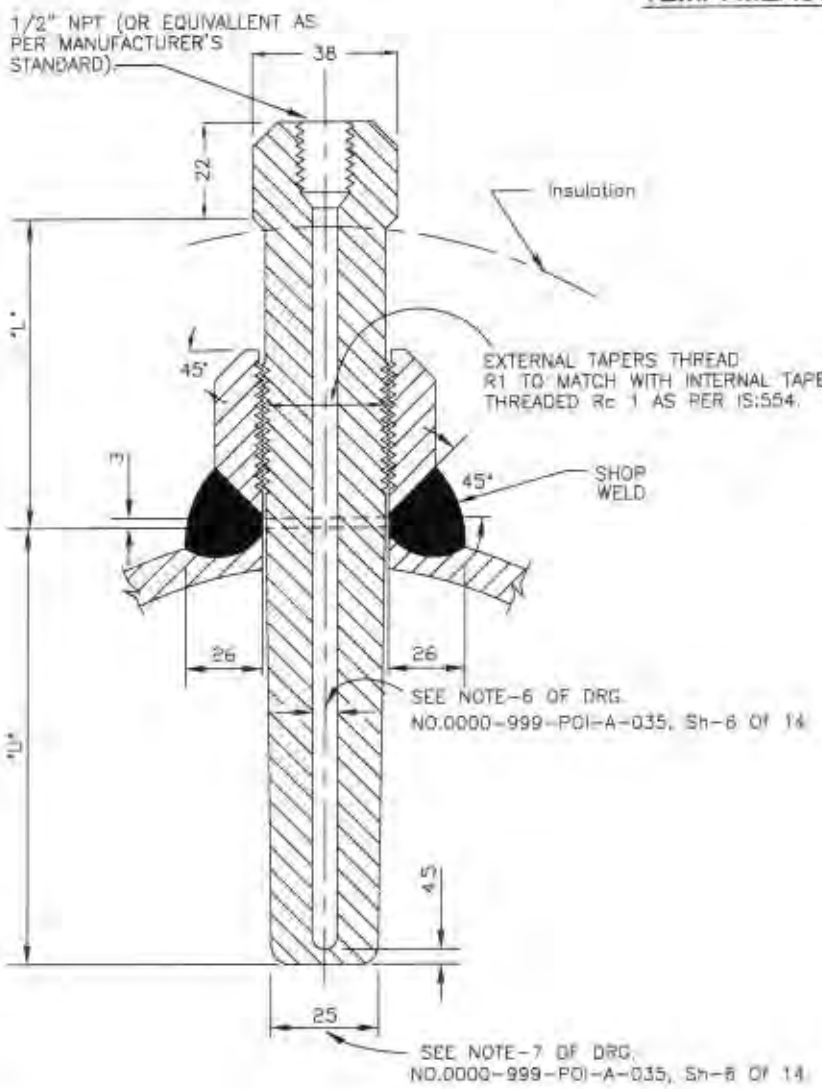
NTPC — NTPC LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO	REV. NO
A4	N.T.S.	0000-999-POI-A-035 Sh-5 Of 14	A

TEMP. MEASUREMENT



NOTES:-

1. THIS TYPE OF TEMPERATURE BOSS IS APPLICABLE FOR THE PROCESS PRESSURE/TEMPERATURE BELOW 40 Kg/Cm2(g)/400°C
2. FOR PRESSURE TIGHT JOINTS THE BOSS SHOULD HAVE INTERNAL TAPERED PIPE THREAD Rc 1 AS PER IS:554, THE LENGTH OF THREAD ENGAGEMENT SHOULD BE AS PER ABOVE STANDARD.
3. PIPES HAVING PROBABILITY OF PROLONGED VIBRATION SEAL WELDING MAY BE DONE ALL AROUND AFTER TIGHTENING THERMOWELL WITHIN THE BOSS.
4. SEE NOTES-2 TO 14 OF DRG. NO. 0000-999-POI-A-035, Sh-6 Of 14.

FOR TENDER PURPOSE ONLY

REV. NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	T.C. C&I	MECH.	APPD.	DATE
A	FIRST ISSUE										

CLEARED BY

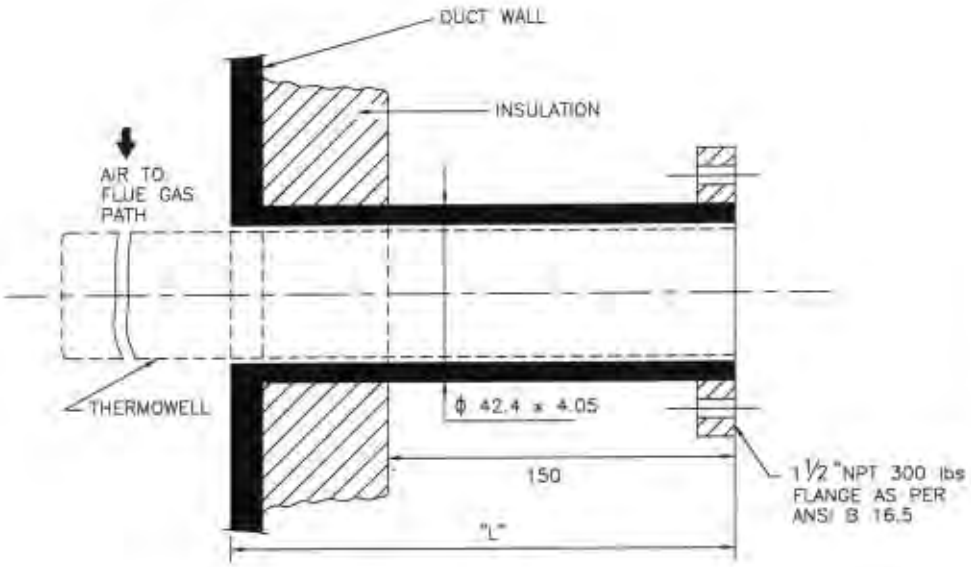
NTPC — N T P C LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT: TYPICAL THERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-7 Of 14	A

TEMP. MEASUREMENT



NOTES:-

1. THIS TYPE OF TEMPERATURE CONNECTIONS SHALL BE PROVIDED FOR TEMPERATURE MEASUREMENT IN AIR AND FLUE GAS DUCT.
2. MATERIAL OF THERMOWELL SHALL BE OF 316SS.
3. EXTERNAL CONNECTION SHALL BE OF SLIP ON FLANGED TYPE AND THERMOWELL DESIGN SHALL BE AS PER ASME.PTC-19.3 (REFER NOTES 9&10 OF DRG.NO. 0000-999-POI-A-035, Sh-6 Of 14).
4. BIDDER TO SUPPLY AND INSTALL THE COUNTER FLANGED AND THERMOWELL (ALONG WITH TEMP. ELEMENT).
5. ALL DIMENSIONS ARE INDICATIVE ONLY.

FOR TENDER PURPOSE ONLY

REV NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	S	T.O. C&I	MECH.	APPD.	DATE
A	FIRST ISSUE										

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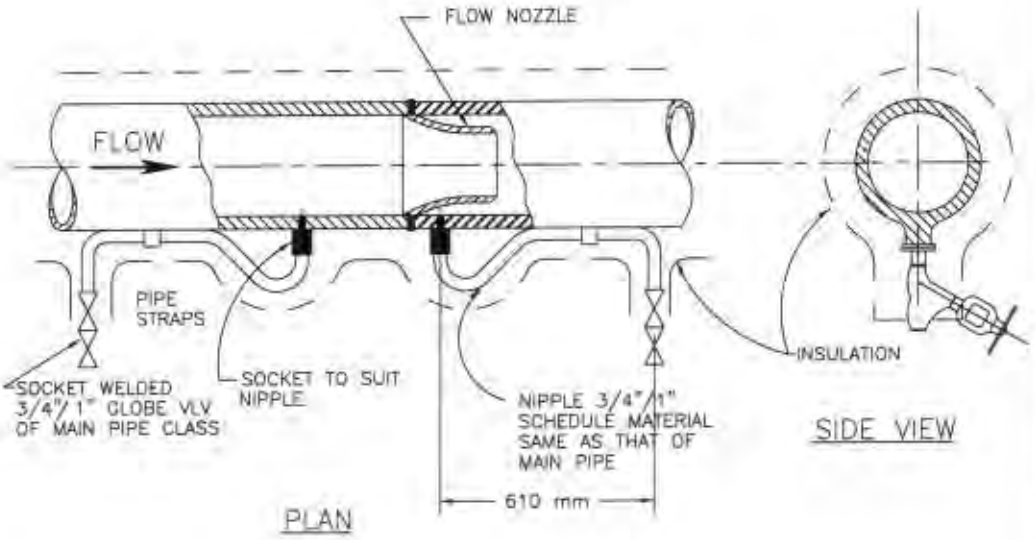
NTPC — NTPC LIMITED (A GOVERNMENT OF INDIA ENTERPRISE) ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-8 Of 14	A

FLOW MEASUREMENT



NOTES:-

1. THIS METHOD OF CONNECTING NIPPLES AND VALVES ON THE HORIZONTAL PIPE IS APPLICABLE FOR MEASUREMENT OF STEAM AT TEMP. ABOVE 455°C .
2. FOR STEAM SERVICE IN HORIZONTAL PIPE THE PRESSURE HOLES AND CONNECTING NIPPLES SHOULD BE IN THE HORIZONTAL PLANE OF THE PIPE CENTRE LINE.
3. THE ENTIRE LENGTH OF THESE NIPPLES AS WELL AS SHUT OFF VALVES SHOULD BE LAGGED IN WITH STEAM LINE AS SHOWN IN THE DRAWING.
4. FLOW ELEMENTS SHALL BE PROVIDED WITH 3 PAIRS OF TAPPING POINTS.

FOR TENDER PURPOSE ONLY

REV.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ARCH	APPD.	DATE
A	FIRST ISSUE							T.G			

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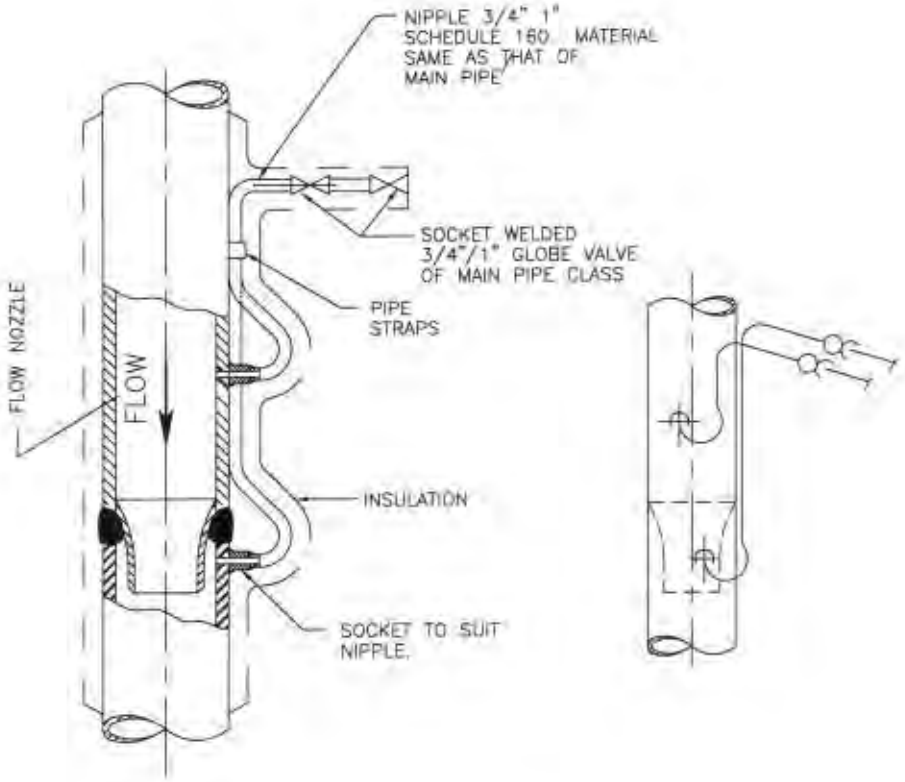
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-0 Of 1A	A

FLOW MEASUREMENT



ELEVATION

NOTES:–

1. THIS METHOD OF CONNECTING NIPPLES AND VALVES ON THE VERTICAL STEAM PIPE IS APPLICABLE FOR MEASUREMENT OF STEAM AT TEMP. ABOVE 455°C
2. THE ENTIRE LENGTH OF THESE NIPPLES AS WELL AS SHUT OFF VALVES SHOULD BE LAGGED IN WITH STEAM LINE AS SHOWN IN THE DRAWING.
3. ON VERTICAL STEAM PIPE BOTH HIGH TEMPERATURE (SPECIAL VENTS) NIPPLES WILL BE LONG ENOUGH SO THAT HIGH AND LOW PRESSURE CONNECTION NIPPLES WILL BE AT SAME LEVEL.
4. UP STREAM AND DOWN STREAM PRESSURE CONNECTIONS MUST BE INSTALLED IN DIFFERENT PLANES PASSING THROUGH THE CENTRE OF THE PIPE.
5. FLOW ELEMENTS SHALL BE PROVIDED WITH 3 PAIRS OF TAPPING POINTS.

FOR TENDER PURPOSE ONLY

NTPC — NTPC LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

REV. NO.	DESCRIPTION	DRAWN/DESIGN	CHKD.	M	E	C	C&I	MECH.	APPD	DATE
A	FIRST ISSUE						T.G.			31.08.10

CLEARED BY

PROJECT: TYPICALTHERMAL POWER PROJECT

TITLE: INSTRUMENT SOURCE CONNECTION DETAILS

SIZE	SCALE	DRG. NO.	REV. NO.
A4	N.T.S.	0000-999-POI-A-035 Sh-10 OF 14	A

PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SITE

1	**PERFORMANCE GUARANTEES:**
1.1	Bidder shall guarantee the CW Temperature for each Cooling Tower as below: The cold-water temperature of 32.5 deg C shall be guaranteed for the design conditions of CW flow, range, ambient WBT and RH as per the performance test procedure attached in the specification. “Predicted cold water temperature” shall be arrived from the guaranteed cold-water temperature by correcting the same for the test conditions of range, ambient conditions and circulating water flow using the performance curves furnished by the contractor. In case the “Test cold water temperature” is higher than the “Predicted cold water temperature”, Employer reserves the right to accept the tower after assessing the liquidated damages. The liquidated damages for shortfall in cold water temperature shall be worked out for all the cooling towers as per relevant clause & sub-section.
1.2	All costs associated with the tests including cost associated with the supply, calibration shall be included in the bid price.
1.3	Complete PG test and Instruments required for conducting the PG Test shall be as per 'CT PG Test Procedure' attached in the specification. PG test equipment being supplied, installed and commissioned for each unit by contractor, shall be retained by end Customer after completion of PG test.
1.4	The Performance / Acceptance test shall be carried out by CTI / NTPC/ Owner approved/listed testing agency as per the standard PG test procedure included in the specification.
1.5	The data logged in the data logger shall be given to END CUSTOMER in soft form for reference immediately after the test, which should be readable in END CUSTOMER computer. In case, any software is required, the same shall be supplied to END CUSTOMER without any extra cost to END CUSTOMER/BHEL. The testing agency shall simultaneously submit their final report to both Contractor as well as END CUSTOMER.
1.6	To ascertain the fulfillment of Guarantees of the Cooling Towers, the test results shall be considered for PG test evaluation and based on the test result, the liquidated damage if applicable shall be levied for the Cooling Towers.
1.7	PG test of Cooling Tower (CT) shall be carried out by the contractor within one year of successful completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified, preferably in the period from May to September. If Unit trial operation falls in these months then PG test of CT can be clubbed with Unit trial operation.
1.8	In case during performance guarantee tests it is found that the equipment/system has failed to meet the guarantees, the Contractor shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL / END CUSTOMER and re-conduct the performance guarantee test(s) with BHEL / END CUSTOMER's consent.
1.9	However, if the specified performance guarantee(s) are still not met even after the above modifications/ replacements within ninety (90) days or a reasonable period allowed by the customer, after the tests have been completed, BHEL/ END CUSTOMER will have the right to accept the equipment / system after levying Liquidated Damages as specified hereunder.
1.10	Bidder shall guarantee the **CW Pumping Head** for each Cooling Tower as below:
1.10.1	The CW Pumping head (MWC) within bidder’s terminal points shall not exceed the respective maximum limits specified in Technical Data Part-A.

1.10.2	Bidder shall submit the CW pumping head calculation along with his technical offer for reference.	
1.10.3	Bids with the CW pump head (MWC) more than the specified maximum limits shall not be accepted and shall be summarily rejected.	
1.10.4	No advantage shall be given to any bidder CW pumping head (MWC) offered less than specified maximum limits.	
1.10.5	The bidder's Cooling Tower thermal design shall take care of above aspects including maximum and minimum permissible plan dimensions indicated in Technical Data Part-A.	
1.10.6	The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subjected to approval.	
1.10.7	For calculating CW Pumping Head, 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 0.01 for all sizes greater than 600NB.The frictional losses shall be computed considering 10% margin on same. William & Hazen formula: V = 0.85 X C X (i)^0.54 X (d/4)^0.63.	
2	**AMOUNT OF LIQUIDATED DAMAGES FOR SHORTFALL IN GAURANTEED PARAMETERS:**	
2.1	If the performance guarantee(s) are not met by the Contractor during PG Test, it will be concluded that, the equipment has failed to meet the guarantee(s) and action shall be taken as per the Contract Requirement.	
2.2	If the performance guarantee(s) specified above are not met by the Contractor even after the modifications and/or replacements mentioned, BHEL / END CUSTOMER will accept the equipment / system only after levying liquidated damages against the Contractor and such liquidated damages shall be deducted from the Contract Price.	
2.3	The liquidated damages, for shortfall in performance indicated are on per unit basis and shall be levied separately for each unit. The liquidated damages shall be prorated for the fractional parts of the deficiencies.	

Guarantee	**Rate of liquidated damages (LD)**
Per Cooling Tower - For every 0.2 deg. C rise in Cold Water Temperature from the guaranteed value	INR 6,61,40,116 (INR Six Crores Sixty One Lakhs Forty Thousand One Hundred Sixteen only) per for every 0.2 deg C rise in cold water temp
Note: The Liquidated damages for Cooling tower shall be pro-rata for fractional parts of the deficiencies.	

2.4	The purchaser is, however, not bound to accept the equipment and reserves the right to reject it if the actual values exceed beyond the plant design limits.	

Schedule of Performance Guarantees

1	Total Guaranteed CW Pumping head (MWC), viz. static head plus frictional losses as below: - Static head upto Top elevation of hot water distribution header from FGL - Frictional losses within bidder's T.P. with 10% margin	
2	Guaranteed Cold water temperature at design capacity & parameters (deg C)	

Signature of authorised Representative

Name

Name & Address of the Bidder

Date

Standard NDCT PG Test Procedure

Introduction

1.1 SCOPE

This document, hereinafter referred to as the “Test Procedure”, describes the procedures for conducting the Cooling Tower Thermal Performance Test at -- x ---- MW(Name of Power Plant) , hereinafter referred to as the “Plant”. This Test Procedure contains guidelines for conducting the test, the test set-up, list of test instrumentation, data to be acquired, and equations to be used for the calculation of results.

1.2 Test Purpose

The Purpose of the Performance Test is to determine the thermal performance of the cooling tower for contractual acceptance.

1.3 Tower Description

The cooling tower, located at the ----------, is a Natural draft counter flow cooling tower.NDCT consists of single hyperbolic tower with total height of ---- m and diameter of ---- m. Hot water is supplied to tower through Hot water header pipe to RCC hot water duct and further cold water collected into a common cold water basin beneath the tower

1.4 Test Agreements

Testing shall be in accordance with CTI ATC-105(Latest Revision), and in accordance with the Contract. Any inconsistencies between any of the provisions in this Test Procedure, and/or any of the Appendices herein, shall be resolved by giving precedence in the following order:

I. The Contract
II. This Test Procedure and any Authorized Modifications
II. Governing Performance Test Code(s) and Standards

1.5 Parties to the Test

The parties to the performance test are as follows:
Owner: -------
Contractor/Manufacturer: ---------

Testing Agency: ----------(Third Party)

Prior to the start of the test, a joint protocol should be signed by representatives declaring that the cooling tower is fit for the test in all respects.

2.0 References and Definitions

Test Codes and Standards:

The following list of Codes and Standards shall be used in part in the testing of the Cooling Tower as deemed applicable by the Contractor.

• *CTI ATC-105 (Latest Revision) Acceptance Test Code for Water Cooling Towers*

3.0 Test Overview

3.1 Test Description

The Purpose of the Performance Test is to determine the thermal performance of the cooling tower for contractual acceptance. The Test will be performed under the general guidelines of the CTI ATC-105 (Latest Revision). The Test will consist of measurements of circulating water flow rate, air and water temperatures, wind speed and direction.

These measured Test parameters will be evaluated with the manufacturer supplied thermal performance curves to determine the thermal performance of the tower by comparing Predicted cold water temperature with the measured cold water temperature.

3.2 Responsibilities
Owner Responsibilities
□□Provide a stable heat load to the tower sufficient for testing.
□□Provide a stable electrical power source for all temporary test instrumentation and equipment required to perform the Test. The Test equipment will require a standard 110 or 220-volt single phase AC power source for the data acquisition system and the psychrometer.
□□Allow full access for the Testing Subcontractor to setup temporary instrumentation.

Contractor / Manufacturer Responsibilities
□□Correct any defects that may occur that prevent the safe and reliable operation of the tower.
Overall Test coordination of all on-site logistical activities.
□□Designate the necessary personnel to witness the execution of the Performance Test.
□□Coordinate with control room operations prior to and during the test.
□□Provide access via ladders, man lifts, or scaffolding as needed including access to pitot taps.

Testing agency Responsibilities
□□Provide temporary test instrument data acquisition system and NIST-traceable, calibrated, temporary test instrumentation.
□□Calibrate temporary test instrumentation prior to the Test.
□□Analyze the test results and prepare a Test Report following the completion of the Test.
□□Provide a Test Director who shall direct, coordinate and oversee the Test activities, and ensure that the Test is executed per this Test Procedure.

3.3 Condition of Equipment
At the time of testing, the tower shall be clean and in good operating condition.

Table 3-1: Required Conditions of the Tower Condition

- The water distribution system shall be essentially free of foreign materials that may impede the normal flow of water.
- The fill and drift eliminators shall be essentially free of algae and other foreign materials that may impede normal air flow.
- The water in the cold water basin shall be at normal operating elevation.

3.4 Pre-Test Preparation
The following pre-test preparations shall be executed under the direction of the Test Director:
Manufacturer
□□Verify the condition of the equipment meets the requirements of Section 3.3.
□□Verify the tower is well balanced prior to flow measurements.

Testing Agency(As Per Contract)

□□Verify all data acquisition systems are running and recording data.
□□Manual data sheets, shown in Appendix B and data collector requirements shall be

determined and made available prior to testing.
□□Any deviations to this Test Procedure identified prior to testing shall be identified and agreed upon in writing by the parties to the test.
□□Test equipment will be checked to insure proper operation prior to testing including temperature comparisons.

3.5 Design Operating Conditions

The Design Operating Conditions of the cooling tower are given in Table below.

Table 1.0: Design Operating Conditions

Parameters	Units	Value
Circulating Water Flow Rate	m3/hr	
Hot Water Temperature	°C	
Cold Water Temperature	°C	
Design Wet-Bulb Temperature	°C	
Relative Humidity	%	
Range	°C	
Barometric Pressure	Pa	

Every effort shall be made to conduct the Test as close to the design operating conditions as possible. The maximum permissible variations from the design operating conditions are given in Table 2 below.

Table 2.0: Maximum Permissible Variation from Design Operating Conditions Parameter Limit

Parameters	Permissible Variations
Circulating Water Flow Rate	± 10%
Range	± 20%
Ambient Wet-Bulb Temperature	± 8.5oC
Ambient Dry-Bulb Temperature	± 14oC
Barometric Pressure	± 3.5 kpa
Wind Speed	<4.5 m/s for the 60 Minutes average & a peak one minute velocity 7.0 m/s at one half of air inlet height.

The Test conditions shall meet the constancy requirements of ATC-105 given in Table:3.0 below.

Table 3.0: Required Constancy of Test Conditions During the Test Parameter Constancy of Test Conditions.

Parameters	Value
Circulating Water Flow Rate	± 2%
Heat Load & Range	± 5%
Wet-Bulb Temperature	± 1.0 oC/hour
Wet-Bulb Temperature maximum deviation of a reading from the test run average	± 1.5 oC

3.6 Test Methodology

3.6.1 There should not be rain two hours prior to test.

3.6.2 The Test shall be performed on the entire tower as a whole. The circulating water flow rate shall be within ± 10% of the average of the tower.

3.6.3 The heat load on the tower should be steady for a minimum of thirty (30) minutes prior to the start of testing.

3.6.4 Test parameters should be measured for as long as Test conditions permit. The Test

Duration shall include a minimum of six one hour period of test data where operating conditions are within the limitations..The most stable data of one hour Period will be utilized to calculate the tower performance. Data stability will be determined by the Test Agency and shall be mutually agreed by Parties to test. The averaged data from the most stable Test run shall be evaluated with the manufacturer's performance curves given in Appendix..

3.6.5 Test parameters will be measured from a combination of temporary test instruments supplied by the Performance Testing Agency and permanent plant instrumentation, see Appendix C. The calibrated accuracy of all instruments shall meet the requirements of ATC-105. Instrument readings will be recorded by the plant control systems, temporary data acquisition system, and manually by test personnel.

3.6.6 Prior to testing, all thermal probe outputs will be compared in a water bath to verify that the probes were not damaged in transit. Only probes which read less than ±0.1°F from the water bath average will be used.

3.6.7 Manufacturer's recommended operating guidelines shall be followed throughout all testing. To the extent practical, systems will be in automatic control during the tests. Any deviation from standard operation should be noted and approved by all parties to the Test.

3.6.8 All flows to and from the tower shall remain steady during each Test Run. If possible, the blowdown shall be isolated and the makeup flow shall remain steady during each Test Run.

3.6.9 A test log should be kept by the Test Director to note any Plant Upsets which may cause the test data to violate the stability criteria or operational limits listed in the Test Procedure and cause test interruption.

3.7 Proposed Test Schedule

----------To be provided by Contractor----

4.0 Test Measurements

4.1 Details

4.1.1 Test measurements shall be recorded with temporary installed instrumentation. Calibration Certificates of Test Instruments shall be handed over to owner 15 days prior to the conductance of Test.

Calibration Frequency:

- Temperature Sensors : within three months prior to use
- Water flow measurement Device: 03 years Prior to Use
- Wind speed : yearly

Ambient wet bulb & dry bulb temperature shall be measured by mechanically aspirated Psychrometers (RTD's accuracy +/- 0.05 Deg C) at a distance between 30 to 100 m & at a height 1.5m above basin Curb elevation. Cold water temperature measurement shall be done by RTD's with +/- 0.05 C accuracy at three equal elevations of each Cold water Discharge Channel of Tower 3X3 (09 points Grid Measurement). Circulating water flow measurements shall be done by Calibrated Pitot (accuracy +/- 3.0% %) through two nos of taps of Hot Water Pipes (Refer: No of readings as per CTI ATC 105) located 90 Degrees to each other. Wind Velocity shall be measured by cup type anemometer(accuracy +/- 0.5 m/s).

4.1.2 Primary measurements are defined as those used to calculate test results.

4.1.3 Secondary measurements are defined as those that do not enter into the calculation of the results. These measurements shall be used as a quality indicator of the test.

4.1.4 All instrumentation for the recording of primary measurements shall be calibrated prior to the performance test in accordance with ATC-105 (Latest Revision). Calibration records for all test instrumentation will be provided when equipment arrives on site prior to testing.

4.1.5 A temporary installed data acquisition system (DAS) shall be utilized to acquire the majority of the test data. Data recorded digitally shall be collected every thirty (30)

seconds.

Calculation of Tower Performance
The calculation of Tower performance will be estimated as per ---- contract clause ------ No.

5.1 Deviation from Design Cold Water Temperature
The cold water temperature shall be read from the performance curves(Approved NDCT Performance Curve) for 90%, 100% and 110% of rated flows at test wet bulb temperature and range & relative humidity. The three points thus obtained from performance curves are plotted to obtain a cross plot, which is a relation between water flow and cold water temperature.

From the cross plot obtained above the predicted cold water temperature shall be read at test water flow.

5.2 Test Acceptance Criteria
The acceptance criterion of the test is defined as: "For the cooling tower, if the test cold water temperature is less than or equal to the predicted cold water temperature.

6.0 Reporting Requirements
6.1 Data Delivery
A copy of all data sheets and logged data will be furnished at the completion of the test prior to demobilization.

6.2 Test Report Delivery
The Performance Test Report shall be submitted within thirty (As per Contract) days of the completion of the Test.

6.3 Final Test Report Requirements
The Performance test report shall include:

□□A copy of all Test data sheets signed by parties to test.

□□A copy of the manufacturer's data including the performance curves.

□□A description of the cooling tower with its orientation.

□□A sketch of the installation showing the measurement location of circulating water

flows, temperatures, wind speed, barometric pressure, etc.

□□Date and time of test runs start and finish.

□□Description of conditions under which the test runs were conducted.

□□Summary and discussion of the Test results.

□□Notes on any unusual observations, data, or conclusions.

□□Signed pre-test agreements.

□□Any mutually-agreed upon deviations to the Test Procedure (if applicable).

□□Instrument calibration data including instrument calibration forms will be supplied

for any temporary test instrumentation used to obtain data for the test.

Appendices

Appendix Title

A. Tower Performance curves

(A wind velocity correction Curve shall be Supplied by manufacturer)

B. Manual Data if any

C. Primary and Secondary Measurements

APPENDIX A
Manufacturers Performance Curves

APPENDIX B
Manual Data Sheets

APPENDIX C
Primary and Secondary Measurements

PRIMARY TEST MEASUREMENTS

Primary measurements are defined as those used to calculate test results. They will be recorded if an electronic interface to the data can be established. A temporary test Data Acquisition System (DAS) shall be used to monitor the majority of the precision test pressures and temperatures. The test DAS will include at least one (1) data logger connected to a laptop computer. Automatically monitored parameters will be scanned a minimum of once every 30 seconds using the test DAS. If the data acquisition system is not available for testing, primary measurements will be manually recorded every five (5) minutes. Location of instruments shall be as per specification.

Primary measurements will be based on the following:

1. Circulating water flow rate will be determined by Pitot tube traverses provided at site. An air-over-water manometer will be used to measure the differential pressure between the impact and the static ports of the pitot. The circulating water flow rate is anticipated to remain steady throughout the mobilization. The water flow to the tower will be measured once, and then checked before each test run by monitoring the manometer differential pressure at the midpoint of the header. The discharge pressure of the circulating pumps, the power consumption of the pumps, and other plant data shall be monitored if available to insure the circulating water flow rate to the tower is steady throughout the test.
2. Hot water temperature shall be measured with two (2) RTDs installed in a flowing well in at least one (1) of the taps at the supply header upstream of first riser. Hot water temperature may be measured in multiple taps if necessary.
3. Cold water temperature shall be measured in cooling tower outlet channel with a grid of at least nine (9) RTD’s installed in the channel at the discharge of the cold water basin.
4. Ambient air wet-bulb temperature will be measured in front of the air inlets using RTDs installed in sixteen (16) CTI - compliant mechanically aspirated psychrometers located at eight (8) equal area points suspended from ropes on each side of the tower.
5. Ambient air dry-bulb temperature will be measured in front of the air inlets using RTDs installed in two (2) of the psychrometers used to measure ambient air wet-bulb temperature. To measure Ambient WBT & DBT, RTDs are to be installed preferably at location approximately 1.5 m above basin curb elevation, not less than 15 m or more than 100 m to windward of the cooling tower or at a suitable location after mutual agreement.
6. Fan motor power readings for the tower will be made at the motor control switchgear with a test agency calibrated wattmeter. Voltage and amperage

measurements will be taken for plant reference and line loss calculations as required.
7. Barometric pressure will be measured with a calibrated barometer near the temporary DAS.
8. Make up water flow and temperature shall be measured with permanent plant instrumentation. If permanent plant instrumentation is not available, makeup water flow shall be approximated from the tower evaporation rate, and makeup water temperature shall be measured with a temporary installed RTD.

SECONDARY MEASUREMENTS

Secondary variables are measured variables that do not enter into the calculation of the results. Secondary measurements are recorded as a quality indicator of the test.
Information Only variables may be recorded for the Test Director's information.

Secondary measurements shall include the following:

The ambient wind speed will be measured with a calibrated RM Young meteorological station placed upwind of the tower in an open and unobstructed location beyond the influence of the inlet air

SUB VENDOR LIST

		PROJECT : CSPGCL 2X660MW Super Critical Thermal Power Project, HTPS Korba West PACKAGE : TG PACKAGE CONTRACTOR: CONTRACT NO :				LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB SUPPLIER APPROVAL			REVISION NO : 00 DATE :22.08.2023 SUB SECTION: QA-TG(MECH)		
Sr No	**Item Description**	**QP Inspection Category**	**QP No**	**QP submission SCH**	**Proposed Sub Supplier**	**Country**	**SS Approval_Status**	**SS Detail Sub.SCH**	**Remark**	**Package Applicable**	**Provenness Clause (Refer Note-1)**
52	**LP Pipes & Fittings (CS & SS)**	**I**			TK Corporation	S Korea	A				
					Dee development	Palwal	A				
					Jindal Saw	India	A		CS (up to 400 NB)		
					Tata	India	A		ERW		
					Surya	India	A		ERW		
					JINDAL PIPES LTD	India	A		ERW		
					WELSPUN	India	A		ERW		
					Lalit Pipes & pipes Ltd.,	Thane	A		EFW Pipes		
					Ratnamni Metals and Tubes Ltd.,	Gandhinagar	A		EFW Pipes		
53	**Butterfly Valves (* Also for steam services)**	**I**			Fouress Engg. *	Bangalore	A		upto 2600 NB		
					IL *	Palakkad	A		upto 2200 NB		
					BHEL *	Bhopal, India	A				
					Kriloskar Bros. Ltd	Pune	A				
					L&T	Chennai	A				
					Trillium Flow	Hubli	A				
					Tyco	Halol	A				
					L&T	Coimbatore	A				
					Nengfa Weiye Tieling Valve Joint Stock Co. ltd.	China	A				
					Intervalve	Pune	A				
54	**Valves (gate/ globe/check) for LP application**	**I**			L&T	Chennai/ Coimbatore	A				
					Velan	Canada/ Coimbatore	A				
					KSB	Germany/ Coimabtore	A				
					ToA	Japan	A				
					Fouress Engg	Aurangabad	A				
					Trillium Flow	Hubli	A				
					Crane	USA	A				
					Samshin	S Korea	A				
					KBL	Pune	A				
					Weir	UK	A				
					Leader	Jalandhar	A				
					BHEL	Trichy	A				
					Pentair (Tyco Sempel)	Trichy	A				
					HP Valves(Key Valves Technology)	Netherlands	A				
					IL	Palakkad	A				
					Steel Strong	Mumbai	A				
55	**HP Feedwater Heaters Automatic (String Bypass) Isolation Valves**	**I**			KSB	Germany	A				
					Tyco Sempell	Germany	A				
					Strack	Germany	A				
					BHEL	Trichy	A				
					Weir Valves & Controls UK Ltd.	UK	A				
					KSB	Germany /Coimbatore	A				
					L&T	Chennai	A				

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					MANGLA HOIST	GREATER NOIDA	A		UP TO 10MT	
3	FAN- AXIAL TYPE > = 5KW	I			CB DOCTOR VENTILLATOR PVT LTD	AHMEDABAD	A		up to 50000 CMH	WTP,CT.AC&VENTILATION,CHP,LHP&GHP,AHP
					HOWDEN SOLYVENT FLAKT INDIA PVT LTD,	CHENNAI	A		up to 125000 CMH	
					C DOCTOR &CO PVT LTD	KOLKATA	A		up to 50000 CMH	
					KRUGER VENTILATION INDUSTRIES (I) PVT LTD	SHAHPUR, THANE	A		Up to 6000 CMH	
					NADI AIRTECHNICS PVT LTD	CHENNAI	A		Up to 15000 CMH	
					ADVANCE VENTILATION PVT LTD	KUNDALI. SONEPAT	A		up to 40000 CMH	
					SK SYSTEMS PVT LTD	KUNDALI PHASE-II, SONEPAT, HARYANA	A		up to 50000 CMH	
					Patel Airflow	Ahemdabad	A		up to 40000 CMH	
					ALMONAROD (P) LIMITED	CHENNAI	A		Up to 14000 CMH	
4	PIPES-MS- (BLACK/ GI) AS PER IS IS:3589 >1000NB	I			STEEL AUTHORITY OF INDIA LIMITED	ROURKELA	A			CW,CT,MUW
					WELSPUN	ANJAR	A		SAW UPTO 2600 NB	
					WELSPUN	BHARUCH	A		SAW UPTO 1300 NB	
					MAN INDUSTRIES	INDORE	A		SAW UPTO 1400 NB	
					SAMSHI	VADODARA	A		SAW 450 TO 2540 NB	
					MUKAT TANKS & VESSELS	TARAPUR	A		SAW 200 TO 1200 NB	
					MUKAT PIPES	RAJPURA	A		SAW UPTO 1800 NB	
					LALIT PIPES AND PIPES LTD	THANE	A		SAW 350 TO 1400 NB	
					RATNAMANI	CHATRAL	A		SAW 600 TO 2600 NB	
					RATNAMANI	KUTCH	A		SAW 400 TO 3600 NB	
					PSL HOLDINGS LIMITED	DAMAN	A		SAW 450 TO 1600 NB	
					PSL INTERNATIONAL LTD.	CHENNAI	A		SAW 450 TO 1600 NB	
					PSL LIMITED	KUTCH	A		SAW 450 TO 1600 NB	
					PSL LIMITED	VISAKHAPATNAM	A		SAW 450 TO 1600 NB	
					JCO PIPES	CHHINDWARA	A		SAW UPTO 1600 NB	

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					SURYA GLOBAL STEEL TUBE LTD	ANJAR	A		SAW UP TO 2032 OD	
					JINDAL SAW LTD	BELLARY	A		SAW UP TO 3632 OD , THICKNESS 16 MM	
					CAPACITE STRUCURES PVT LTD	THANE	A		406.4 MM TO 3874 MM OD	
5	PIPES & FITTINGS-GRP	I			EPP COMPOSITES PVT LTD	RAJKOT	A		UP TO 900MM	WTP,CT
					GRAPHITE INDIA	NASIK	A		UP TO 1000MM	
					SHRIRAM SEPL COMPOSITES LTD	CHENNAI	A		UP TO 1100MM	
					BALAJI FIBER REINFORCE PVT LIMITED	VADODARA	A		UP TO 650MM	
					MEGHA FIBRE GLASS INDUSTRIES PVT LTD	MEDAK	A		UP TO 900MM	
6	SERVICE VESSEL-CPU & OTHER PR VESSELS >= 10 BAR WORKING PRESSURE	I			DRIPLEX WATER ENGINEERING INTERNATIONAL PVT LIMITED	BHADARBAD	A			WTP,CPU,CAS,CHP, LHP&GHP,AHP
					BGR ENERGY SYSTEMS LTD (ENVIRONMENTAL ENGG. DIV.)	PONNERI	A		UPTO 3000MM DIA & THICKNESS UPTO 28 MM	
					ISHAN EQUIPMENTS PRIVATE LIMITED	VADODARA	A		UPTO 2900 MM DIA & THICKNESS UPTO 28 MM	
					JASMINO POLYMERTECH PVT LTD	TALOJA	A		DIA 2800MM, THICNKESS 25MM DESIGN PRESSURE UP TO 47.5 KSC	
					MAHIMA UDYOG	HARIDWAR	A		DIA UP TO 2900 MM , THICKNESS UPTO 29 MM	
					BELCO POLLUTION CONTROL PVT LTD	GREATER NOIDA	A		UPTO 3200MM DIA & THICKNESS UPTO 30 MM	
7	PUMPS- HORIZONTAL & VERTICAL CENTRIFUGAL - UP TO 300KW	(UP TO 60 KW CAT-II , ABOVE 60 KW CAT-I)			KIRLOSKAR BROTHERS LTD	KIRLOSKARWADI	A			WTP,CW, CPU,FDPS,CHP, LHP &GHP,AC & VENTILATION,MUW, AHP
					WILO MATHER & PLATT	PUNE	A			
					WILO MATHER & PLATT	KOLHAPUR	A			
					SAM TURBO	COIMBATORE	A		FLOW UP TO 1500 CUM/HR AND POWER RATING UP TO 425 KW	
					FLOWMORE LTD	GHAZIABAD	A			
					BEST AND CROMPTON	CHENNAI	A			
					JYOTI LTD	VADODARA	A			
					WPIL	GHAZIABAD	A			
					KISHORE PUMPS	PUNE	A		UPTO 500M3/HR ONLY RUBBERLINED PUMPS ALSO	
					GRUNDFOS PUMPS INDIA PVT LTD	CHENNAI	A		HORIZONTAL UP TO 30 KW ONLY AND VERTICAL UP TO 45 KW ONLY (FOR APPLICATIONS WHERE NPSH IS NOT	
					SINTECH PRECISION	GHAZIABAD	A		HORIZONTAL UP TO 400 KW MOTOR RATING AND VERTICAL UP TO 30 KW MOTOR RATING	

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					KSB	PUNE	A			
					KSB	NASHIK	A			
					FLOWSERVE INDIA CONTROLS PVT LTD	COIMBATORE	A		HOIZONTAL CENTRIFUGAL PUMP UP TO 75 KW ONLY	
					SU MOTOR	MUMBAI	A		HORIZONATL UPTO 500M3/HR ONLY RUBBERLINED PUMPS AND VERTICAL CENTRIFUGAL PUMPS UP TO 100CMH ONLY	
					BHARAT PUMPS AND COMPRESSORS	NAINI	A		FLOW UP TO 2200 M3/HR AND HEAD UP TO 60 MWC	
8	PUMPS -VT -UP TO 300KW	I			FLOWMORE LTD	GHAZIABAD	A			WTP, CW
					KIRLOSKAR BROTHERS LIMITED	KIRLOSKARWADI	A			
					WPIL LTD	KOLKATA	A			
					WPIL LTD	GHAZIABAD	A			
					JYOTI LTD	VADODARA	A			
					XYLEM WATER SOLUTIONS INDIA PVT LTD	VADODARA	A			
					FLOWSERVE INDIA CONTROLS PVT LTD	COIMBATORE	A		UP TO 1025 KW	
					SINTECH PRECISION	GHAZIABAD	A			
					WILO MATHER & PLATT	PUNE	A			
9.A	VALVE-DUAL PLATE CHECK > 600MM OR CLASS > 300 (VALVE- DUAL PLATE CHECK UP TO 600MM & CLASS 300: CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			ADVANCE VALVE PVT LTD	GR. NOIDA	A		DUAL PLATE CHECK VALVES CI UPTO 1000 NB CLASS 125, DUPLEX SS UP TO 600NB CLASS 600.	WTP,CW, CPU,FDPS,CAS,LP PIPING
					LEADER VALVES	JALANDHAR	A		UP TO 900MM CLASS 150 , SS 200NB CLASS#300	
					R & D MULTIPLE	VALSAD	A		CI/ CS UP TO 800NB PN 10	
9.B	VALVE-BALL > 100 MM OR CLASS > 800; (VALVE- BALL UP TO 100 MM & CLASS 800:CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			SWIMS TECHNOLOGIES	HUBLI	A		SS BALL VALVES UP TO 500MM AND CLASS #600, CS BALL VALVES UP TO 250 MM AND CLASS# 900, CS/ SS BALL VALVES UP TO 100 MM AND CLASS # 1500.	WTP, CPU,FDPS,CAS,FOH,CHP, LHP&GHP,AHP
					MICRO FINISH VALVES PVT. LTD.	HUBLI	A		400NB CLASS#600 AND UP T0 600NB CLASS#300	
					FLOW CHEM INDUSTRIES	KALOL	A		100NB CLASS#600,200NB CLASS#300, 50 NB CLASS#800	
					L&T VALVES LIMITED	COIMBATORE	A		UPTO 150NB, CLASS #150/300, AND UPTO 50NB, CLASS #800	
					PRECISSION ENGG CO VALVES PVT LTD	NASIK	A		FCS UP TO 50NB CLASS 800, CCS UP TO 400NB CLASS 150.	
					BELGAUM AQUA VALVE PVT LTD	BELGAON	A		FCS UP TO 50NB CLASS 800, CCS UP TO 200NB CLASS 150.	
					G M ENGINEERING PRIVATE LTD	RAJKOT	A		UP T0 400 NB AND CLASS #600	

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9.C	VALVE-BUTTERFLY > 600MM OR CLASS>150 (VALVE-BUTTERFLY UP TO 600MM & CLASS 150::CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			INTERVALVE POONAWALA LTD	PUNE	A		SGI / CI / D2 1400MM PN10, SGI / CI 1000MM PN16,CS/SS 500MM PN16, SS 400MM CLASS#300. MS FABRICATED UPTO 2000NB.	WTP, CW,CT,CPU,FDPS,CAS, AC& VENTILATION, MUW,CHP, LHP&GHP,LP PIPING,AHP
					SWIMS TECHNOLOGIES	HUBLI	A		CI/ DI BUTTERFLY VALVE UP TO 1000MM AND PN16 AND UP TO 1800MM AND PN10,CCS UP TO 1050MM CLASS 150 AND UP TO	
					PENTAIR VALVES	HALOL	A		FOR SS UP TO 500 NB PN-10, CI- UP TO 900NB PN-10, UP TO 500NB PN-16, 450MM CLASS#300. MS FABRICATED UPTO 2800NB.	
					FOURES ENGINEERING	BANGALORE	A		CAST SGI/CI/ MS FABRICATED- UP TO 1200 PN-10, UP TO 350 PN-16 ,2400 MM PN6/CLASS150 SS - UP	
					KIRLOSKAR BROTHERS LTD	KONDHAPURI	A		CAST SGI/CI/CS 1400 MM PN16 , SS 300 MM PN16 , 1800MM CLASS 150, MS FABRICATED 900 NB PN40.MS FABRICATED 2800NB. PN6.	
					R & D MULTIPLE	VALSAD	A		CAST SGI/CI/MS FABRICATED- UP TO 1800 MM PN-10/CLASS # 75, ,1100MM PN25.1400MM CLASS#150 .MS FABRICATED	
					ADVANCE VALVES PVT LTD	GREATER NOIDA	A		METAL SEATED, TRIPLE ECCENTRIC, SS BFV OF SIZE UPTO 100NB, AND PRESSURE RATING UPTO CLASS #300.	
					BRAY CONTROLS INDIA PVT. LTD	KANCHIPURAM	A		UPTO 450 MM AND CLASS#600	
					INSTRUMENTATION LTD.	PALAKKAD	A		UPTO 2200NB CLASS # 75	
					HAWA ENGINEERS	AHMEDABAD	A		CI/ CS & FABRICATED UPTO 1200MM, CLASS #150, SS UPTO 250MM, CLASS#150	
					CRANE PROCESS FLOW	SATARA	A		UP TO 900MM PN10	
					L & T VALVES LIMITED	COIMBATORE	A		UP TO 900MM CLASS 150	
					DEMBLA VALVES	THANE	A		UP TO 2200MM CLASS#75	
9.D	VALVE-CONVENTIONAL GATE / GLOBE / CHECK > 600NB OR CLASS > 300	II			LEADER VALVES	JALANDHAR	A		CS GATE 600MM CLASS#600, SS GLOBE 600MM CLASS#600, CS CHECK 600MM AND CLASS#600	WTP, CW,CT,CPU,FDPS,CAS, AC& VENTILATION, MUW,CHP, LHP&GHP,LP PIPING,AHP
					HAWA ENGINEERS	AHMEDABAD	A		FCS / FSS 50 NB CLASS 800.	
					FOURES ENGINEERINGS	THANE	A		400NB CLASS 600 AND 50NB CLASS 800.	
					BHEL IVP	GOINDWAL	A		GATE UP TO 300 NB CLASS 600. GLOBE 250 NB CLASS 400, CHECK 150NB CLASS 600.	
					HITECH ENGG PVT LTD	AHEMDABAD	A		50 NB CLASS 800.	
					KSB PUMPS LTD	COIMBATORE	A		300NB CLASS 2500.	
					NITON VALVES INDIA PVT LTD	NAVI MUMBAI / AURANGABAD	A		CS GATE 900 NB CLASS 600, CHECK 300 NB CLASS 600.	
					L&T VALVES LIMITED	COIMBATORE	A		650 MM CLASS 600, 50 NB CLASS 800.	
					SWIMS TECHNOLOGIES	HUBLI	A		CONVENTIONAL CCS GATE / GLOBE / CHECK VALVES UP TO 600MM AND CLASS # 1500, CSS GATE/ GLOBE/ CHECK VALVES UP TO 200MM	
9.E	VALVE- DIAPHGRAGM TYPE	I			CRANE PROCESS FLOW	SATARA	A		UP TO 300NB PN10	WTP,CPU
					SWIMS TECHNOLOGIES	HUBLI	A		UPTO 250 NB - PN 10, 350MM PN6	
					PROCON ENGINEERS	MUMBAI	A		UPTO 200 NB AND PN 10/CLASS #150	

एनटीपीसी NTPC	Project/ परियोजना : 2 X 660 MW SUPER CRITICAL THERMAL POWER PROJECT, HTPS, KORBA WEST Package/ पैकेज : EPC Supplier/ आपूर्तिकर्ता: Contract No./ अनुबंध सं.:	INDICATIVE LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL क्वालिटी प्लान तथा सब -वेंडर के अनुमोदन सहित मदों की सूची SUB-SYSTEM उप-प्रणाली: BOP SYSTEMS (MECHANICAL)				DOC. NO./ दस्तावेज सं.: REV. NO.: DATE/ तिथि : 14.08.23 PAGE/ पृष्ठ :				
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9.F	VALVE-PLUG > 100 MM OR CLASS > 800(VALVE-PLUG UP TO 100 MM & CLASS 800:CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			SWIMS TECHNOLOGIES	HUBLI	A		SOFT SEATED 400MM AND CLASS #150, 300NB CLASS#300	WTP,CPU,CHP, LHP&GHP, FOH,AHP
					XOMOX SANMAR	TRICHY	A		UP TO 600MM AND CLASS#300	
					FLOWSERVE INDIA CONTROLS	CHENNAI	A		METALLIC SEATED 400NB CLASS#150, 300NB CLASS #300, 50NB CLASS #800	
10	PUMP -SUBMERSIBLE>= 30KW	I			KSB	NASHIK	A		130 KW	WTP,CT, CPU,CHP, LHP&GHP, FOH,AHP.LP PIPING,FDPS
					KIRLOSKAR BROTHERS LTD	KIRLOSKARWADI	A			
					AQUA MACHINERY	AHMEDABAD	A		UP TO 235 KW	
					WPIL	GHAZIABAD	A			
11	RUBBER EXPANSION JOINT>=1600NB (RUBBER EXPANSION JOINT < 1600NB: CAT-II & MAIN CONTRACTOR APPROVED SOURCES)	I			CORI ENGINEERS PVT LTD	CHENNAI	A		UPTO 2800 MM	ACW, ECW, CW,CT
					SRM EXOFLEX PVT LTD	KOLKATA	A		UPTO 2800 MM	
12	FAN ASSEMBLY-COOLING TOWER	I			PAHARPUR COOLING TOWERS LTD	SAHIBABAD	A		WITH SOLID FAN BLADES 288" AND 336 " DIA, WITH FOAM CORED FAN BLADES WITH 10METERS AND 10.97 METERS	CT
					PAHARPUR COOLING TOWERS LTD	BHASA	A		60" TO 288" FAN DIA	
					PAHARPUR COOLING TOWERS LTD	KOLKATA	A		60" TO 288" FAN DIA	
					M/s MAYA FANS AIR ENGG PVT LTD,	DEWAS	A		UP TO 11 METER FAN DIA	
					AMALGAMATED INDUSTRIAL COMPOSITES PVT LTD	NASHIK	A		UP TO 11 METER FAN DIA	
13	GEAR BOX -COOLING TOWER	I			PAHARPUR COOLING TOWERS LTD	SAHIBABAD	A			CT
					PAHARPUR COOLING TOWERS LTD	KOLKATA	A			
					NEW ALLENBERRY WORKS	KOLKATA	A			
					ELECON ENGINEERING	VALLABH VIDYANAGAR	A			
					PREMIUM ENERGY TRANSMISSION LTD.	FALTA	A			
14	DRIVE SHAFT-CARBON FIBRE -COOLING TOWER	II			M/S EUROFLEX TRANSMISSION (INDIA) PVT LTD	HYDERABAD	A			CT
					PAHARPUR COOLING TOWERS LTD	SAHIBABAD	A			
					M/s AMALGAMATED INDUSTRIAL COMPOSITES PVT LTD	NASHIK	A			
					NORTH STREET COOLING TOWERS	GHAZIABAD	A			
15	DRIVE SHAFT SS-COOLING TOWER	II			PAHARPUR COOLING TOWERS LTD	SAHIBABAD	A			CT
					PAHARPUR COOLING TOWERS LTD	KOLKATA	A			

एनटीपीसी NTPC	Project/ परियोजना : 2 X 660 MW SUPER CRITICAL THERMAL POWER PROJECT, HTPS, KORBA WEST Package/ पैकेज : EPC Supplier/ आपूर्तिकर्ता: Contract No./ अनुबंध सं.:	INDICATIVE LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL क्वालिटी प्लान तथा सब -वेंडर के अनुमोदन सहित मदों की सूची SUB-SYSTEM उप-प्रणाली: BOP SYSTEMS (MECHANICAL)				DOC. NO./ दस्तावेज सं.: REV. NO.: DATE/ तिथि : 14.08.23 PAGE/ पृष्ठ :				
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79	Steel Cord Pipe Conveyor (FR Grade)	I			Phonix Cnoveyor belt	Kolkata	A		Upto 2400 MM B/w	
					Oriental Rubber	Pune	A		Upto 2000 MM B/w	
					Forech India Pvt Ltd	Cheyyar	A		Upto 2000 MM B/w	
80	PIPE-SS ASTM A 312	II			REMI	TARAPUR	A		ERW UPTO 400 NB,SEAMLESS UP TO 200NB	
					RATNAMANI	MEHSANA	A		ERW UPTO 500 NB, SEAMLESS UPTO 50 NB ONLY	
					RATNAMANI	KUTCH	A		ERW UPTO 400 NB, SEAMLESS UPTO 50 NB ONLY, ARC WELDED UP TO 450NB	
					BHANDARI FOILS & TUBES LIMITED	DEWAS	A		ERW UP TO 300NB	
					APEX	BEHRORE	A		ERW UPTO 400 NB, SEAMLESS UPTO 50 NB.	
					PRAKASH STEELAGE	SILVASA	A		ERW UP TO 203NB	
					SHUBHLAXMI METALS AND TUBES	UMBERGAON	A		SEAMLESS UP TO 150MM and ERW UP to 250 NB Sch 40S	
81	PIPE-CS SEAMLESS ASTM A 106	II			ISMT	AHMADNAGAR	A		UPTO 273 MM OD	
					ISMT	BARAMATI	A		UPTO 273 MM OD	
					REMI	BHARUCH	A		UPTO 177.8 MM OD	
					MAHARASHTRA SEAMLESS	RAIGAD	A		UPTO 500 NB	
82	HCSD PUMP	I			WEIR MINERALS	NETHERLANDS	A			
					ABEL	GERMANY	A			
					FELUWA	GERMANY	A			
83	GEAR BOX -ASH CONDITIONER	I			BONFIGLIOLI TRANSMISSIONS PVT LTD	CHENNAIL	A		BEVEL HELICAL GEAR TA SERIES	
ITEM WITH MAIN CONTRACTOR / BIS APPROVED SOURCES.										
1	BRANCH PIPE , COUPLING & NOZZLE (SS & GM)	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE					FDPS
2	FIRE EXTINGUISHER	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE					FDPS
3	WATER MONITOR	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE					
4	PIPES-MS- (BLACK/ GI) AS PER IS:1239 & IS:3589 UPTO 1000 NB	II			(BIS MARKED, MANUFACTURERS WITH VALID BIS LICENSE)					WTP,CW,CT,CPU,FDPS,AC&VENTILATION,CHP,LHP&GHP,AHP
5	FIRE HOSE	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE					FDPS
6	HYDRANT VALVE	II			BIS APPROVED SOURCES WITH VALID BIS LICENSE					

एनटीपीसी NTPC	Project/ परियोजना : 2 X 660 MW SUPER CRITICAL THERMAL POWER PROJECT, HTPS, KORBA WEST Package/ पैकेज : EPC Supplier/ आपूर्तिकर्ता: Contract No./ अनुबंध सं.:	INDICATIVE LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL क्वालिटी प्लान तथा सब -वेंडर के अनुमोदन सहित मदों की सूची SUB-SYSTEM उप-प्रणाली: BOP SYSTEMS (MECHANICAL)			DOC. NO./ दस्तावेज सं.: REV. NO.: DATE/ तिथि : 14.08.23 PAGE/ पृष्ठ :				
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7	PIPES FOR IDLERS IS 9295	III			BIS APPROVED SOURCES WITH VALID BIS LICENSE					FDPS
8	BLOWERS -CENTRIFUGAL >=5KW	II			MAIN CONTRACTOR APPROVED SOURCES					WTP
9	ClO2 GENERATOR	II			MAIN CONTRACTOR APPROVED SOURCES					WTP
10	JOINT /FITTING COATING MATERIAL(SLEEVE) FOR 3 LPE PIPES	II			MAIN CONTRACTOR TO PROPOSED VENDOR FOR NTPC APPROVAL					MUW
11	PIPING FABRICATION -HP>300PSI	II			MAIN CONTRACTOR APPROVED SOURCES					WTP,CPU
12	PUMP-METERING/DOSING	II			MAIN CONTRACTOR APPROVED SOURCES					WTP,CPU
13	PUMP - PP- ACID/ ALKALI UNLOADING	II			MAIN CONTRACTOR APPROVED SOURCES					WTP,CPU
14	PUMPS-SCREW TYPE	II			MAIN CONTRACTOR APPROVED SOURCES					WTP,CPU,FOH
15	RUBBER LINING OF TANKS/ VESSELS/ PIPES/ VALVES/FITTINGS	II			MAIN CONTRACTOR APPROVED SOURCES					WTP,CPU
16	RO PRESSURE TUBE	II			MAIN CONTRACTOR APPROVED SOURCES					WTP
17	TUBE SETTLER MEDIA	II			MAIN CONTRACTOR APPROVED SOURCES					WTP
18	WRAPPING & COATING MATERIAL -ANTI CORROSIVE TAPE	II			MAIN CONTRACTOR APPROVED SOURCES					CW,CT,LP PIPING, FDPS
19	DRIFT ELIMINATOR-PVC	II			MAIN CONTRACTOR APPROVED SOURCES					CT
20	FAN CYLINDER SEGMENTS-FRP-COOLING TOWER	II			MAIN CONTRACTOR APPROVED SOURCES					CT
21	COOLING TOWER FILLS	II			MAIN CONTRACTOR APPROVED SOURCES					CT
22	SHAFT-CARDON TYPE-CW PUMP	II			MAIN CONTRACTOR APPROVED SOURCES					CW
23	DUST EXTRACTION SYSTEM	I			MAIN CONTRACTOR's APPROVED SOURCES				BOIs SHALL BE FROM NTPC APPROVED SOURCES	CHP, LHP/GHP
24	DUST SUPPRESSION SYSTEM (PLAIN WATER)	I			MAIN CONTRACTOR's APPROVED SOURCES				BOIs SHALL BE FROM NTPC APPROVED SOURCES	CHP, LHP/GHP
25	DUST SUPPRESSION SYSTEM (DRY FOG)	I			MAIN CONTRACTOR's APPROVED SOURCES				BOIs SHALL BE FROM NTPC APPROVED SOURCES	CHP, LHP/GHP

Note-1 Items for which Sub-QR is enviisaged, vendors are accepted subject to Sub-QR clearance from NTPC Engg.

A – For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list along with the condition of approval, if any./ इन मदों के लिए प्रस्तावित वेंडर एनटीपीसी को स्वीकार्य है। अनुमोदन की शर्त, , यदि कोई हो, के साथ-साथ पत्र "क" में इंगित किया जाए ।

DR – For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list. एनटीपीसी द्वारा इन मदों की समीक्षा के लिए "विस्तृत ब्यौरे की आवश्यकता" होगी। सूची में "DR" पत्र में इंगित किया जाना चाहिए।

QP / INSPECTION CATEGORY:

CAT-I / श्रेणी- I: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है और एनटीपीसी द्वारा अंतिम स्वीकृति भौतिक निरीक्षण के दौरान उपलब्ध गवाह के आधार पर दी जाएगी।

CAT-II / श्रेणी- II: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP. इन मदों के लिए गुणवत्ता योजनाओं को एनटीपीसी द्वारा अनुमोदित किया जाता है। हालाँकि एनटीपीसी द्वारा कोई भौतिक निरीक्षण नहीं किया जाएगा। एनटीपीसी द्वारा अंतिम स्वीकृति अनुमोदित क्यूपी के अनुसार दस्तावेजों की समीक्षा के आधार पर दी जाएगी।

एनटीपीसी NTPC	**Project/ परियोजना : 2 X 660 MW SUPER CRITICAL THERMAL POWER PROJECT, HTPS, KORBA WEST** **Package/ पैकेज : EPC** **Supplier/ आपूर्तिकर्ता:** **Contract No./ अनुबंध सं.:**	**INDICATIVE LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL** **क्वालिटी प्लान तथा सब -वेंडर के अनुमोदन सहित मदों की सूची** **SUB-SYSTEM उप-प्रणाली: BOP SYSTEMS (MECHANICAL)**				**DOC. NO./ दस्तावेज सं.:** **REV. NO.:** **DATE/ तिथि : 14.08.23** **PAGE/ पृष्ठ :**				
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CAT-III/ श्रेणी-III : For these items Quality control to be exercised as per Main contractor Quality Assurance System. The final acceptance by NTPC shall be on the basis of Certificate of Conformance (COC) by Main Contractor.										
UNITS/WORKS इकाईयां / कार्य: Place of manufacturing/ निर्माण का स्थान Place of Main Supplier of multi units/works/बहु- इकाइयों / कार्यों के मुख्य सप्लाइर का स्थान.										
FORMAT NO./ प्रारूप सं: QS-01-QAI-P-1B/F1-R0						Engg. Div. / QA&I				

11	**LT MOTOR**	**CAT - I**								
					ABB	FARIDABAD	A*	* SUBJECT TO VERIFICATION VISIT	UPTO 55KW	
					ABB	BANGALORE	A*		UPTO 690V, 475kW	
					JYOTI LTD.	VADODARA	A			
					TIPM	JAPAN	A		UPTO 15 KW (NON FLAME PROOF)	
					HYOSUNG	SOUTH KOREA	A			
					WEG	BRAZIL	A			
					HYUNDAI	SOUTH KOREA	A			
					LHP	SOLAPUR	A		UPTO 400KW FROM B-16 WORKS. UPTO 200KW FROM B-11 WORKS.	
					CGL	AHMEDNAGAR	A		RQP, FOR FLAME PROOF MOTOR	
	Refer Note-7				TMEIC	JAPAN (NAGASAKHI)	A			
					NGEF	BANGALORE	A		UPTO 15 KW	
					BHARAT BIJLEE	MUMBAI	A		RQP, FOR FLAME PROOF ALSO	
					KEC	BANGALORE/ HUBLI*	A		*UPTO 90KW, RQP, FOR FLAME PROOF ALSO	
					MARATHON	KOLKATA	A		RQP (UPTO 690V & 600 KW) FOR FLAME PROOF ALSO	
					ABB	SWEDEN	A		UPTO 55KW	
					HAVELL	NEEMRANA	A		UP TO 90KW	
					KAWAMATA	JAPAN	A		UP TO 75 KW	
					HEM Industries	DAMAN	A		UP TO 30 KW	
					TIPS	JAPAN	A		UP TO 45KW	
11.1	**DC Motor**	**CAT I**								
					CGL	MANDIDEEP	A			

					Universal Cable Ltd.	Satna	A				
27	**1.1 KV LT Power Cables (Type- XLPE Insulated, PVC sheathed (incl FRLS)**	**Refer Note-5**									
					Advance Cable	Bengaluru	A				
					Apar Industries Ltd	Umbergaon	A				
					Cords Cables	Bhiwadi	A				
					CMI	Baddi	A				
					Delton Cable Ltd	Faridabad	A				
					Dynamic Cables	Jaipur	A				
					Gemscabs Industries	Bhiwadi	A				
					Gupta Power Cables	Khurda	A				
					Havells India Ltd.	Alwar	A				
					KEC International	Silvassa , Mysore	A				
					KEI Industries	Bhiwadi	A				
					Paramount Cable	Khushkhera	A				
					Polycab Wires Pvt. Ltd	Daman	A				
					Ravin Cables	Pune	A				
					Special Cables	Rudrapur	A				
					Suyog Cables	Vadodara	A				
					Thermocables	Hyderabad	A				
					Tirupati Plastomatics	Jaipur	A				
					Torrent Cable Ltd	Nadiad	A				
					Universal Cable Ltd.	Satna	A				
28	**LT Control Cable 1.1 KV, Type - PVC (incl FRLS)**	**Refer Note-5**									
					Advance Cable	Bengaluru	A				
					Apar Industries Ltd	Umbergaon	A				
					Cords Cables	Bhiwadi	A				
					CMI	Faridabad	A				
					CMI	Baddi	A				
					Delton Cable Ltd	Faridabad	A				
					Elkay Telelink	Faridabad	A				
					Gemscabs Industries	Bhiwadi	A				
					Goyoline Fibres (I) Ltd	Daman	A				
					Gupta Power Cables	Khurda	A				
					Havells India Ltd.	Alwar	A				
					KEC International	Silvassa , Mysore	A				
					KEI Industries	Bhiwadi	A				
					Paramount Cable	Khushkhera	A				
					Polycab Wires Pvt. Ltd	Daman	A				
					Ravin Cables	Pune	A				
					Special Cables	Rudrapur	A				
					Suyog Cables	Vadodara	A				
					Thermocables	Hyderabad	A				
					Tirupati Plastomatics	Jaipur	A				
					Torrent Cable Ltd	Nadiad	A				
					Universal Cable Ltd.	Satna	A				

31	**GI CABLE TRAYS AND ACCESSORIES (LADDER & PERFORATED TYPE), fitting & accessories including bends**	**Refer Note-6**									
					Inar Profiles Ltd	Enkapalli (Vishakhapatnam)	A				
					Vatco	Mumbai	A			Galvanization at Sigma Mumbai	
					Indiana cable trays	Mumbai	A			Galvanization at Karamtara galvanizer-Mumbai	

					Industrial Perforation	Kolkata	A		Galvanized and offered for inspection at Industrial Perforation Pvt Ltd, Ganganagar , Kolkata, WB	
					Ratan Projects	Howrah	A		Galvanization at DMP Projects- Howrah	
					India Electric Syndicate	Kolkata	A		Galvanization at BMW Industries/B.P Projects- Howrah	
					Steelite engg.	Mumbai	A			
					Premier Power Products	Howrah	A		Galvanising at Neha Galvaniser- Howrah	
					Indiana Gratings	Pune	A			
					M.J. Engineering	Okhla/ Bhiwadi	A			
					Maheshwari	Ghaziabad	A		Galvanization at NTPC approved Galvaniser.	
					T.R.G	Chennai	A		Galvanization at TM Radhakrishna Chetty & Co-Chennai	
					Amtech	Pune	A		Galvanization at B.G. Shirke - Pune	
					Kannade Anand Udyog	Mumbai	A		- **Fabrication at their units:** Plot No. 42, Morivali, MIDC, Thane & Plot No.: D-35 Anand Nagar MIDC, Addl. Ambernath , Thane - **Galvanization and offer the galvanized trays for inspection at:** Plot No. D-34 Anand Nagar MIDC, Addl. Ambernath,Thane	
					Rukmani	Raipur	A		Ladder type cable trays only	
					Passive Infra	Hasangarh (Rohtak)	A			
					Unitech Fabricators & Engineers	Howrah/ Hoogly	A			
					Patny System	Hyderabad	A			
					Rabi Engg	Kolkata	A		Galvanizing from NTPC approved sources	
					MKSD Industries	Taloja	A		Galvanization from Encorp Power Trans-Palghar	
					Reliable Sponge	Kalunga	A			
					Pinax Steel	Patna	A			
					Rukmani	Hoogly	A		Galvanization at Rukmani Fab & Gal-Howrah	
31.1	**GI FLEXIBLE CABLE TRAY SUPPORT SYSTEM**	**Refer Note-6**								
					Vatco	Mumbai	A		Galvanising at Sigma Mumbai	
					Inar profiles	Enkapalli	A			
					Industrial perforations	Kolkata	A			
					Premier power products	Howrah	A		Galvanising at Neha Galvaniser- Howrah	
					Steelite engg.	Mumbai	A			
					Indiana gratings	Pune	A		Galvanising at Poona Galvaniser- Pune	
					Amtech	Pune	A		Galvanising at B.G. Shirke- Pune	
					Ratan Projects	Howrah	A		Galvanization at NTPC approved sources	
					Patny Systems	Hyderabad	A			
32	**Galvanised Steel Structure**	**CAT II**								
					Sangam Structural Ltd	Prayagraj	A		Galvanising at NTPC approved sources	
					RS Infraprojects	Ghaziabad	A			
					Anil Steels	Rohtak	A			
					Jamuna Metals	Delhi	A			
					Pioneer Fabricators	Meerut	A			
					Passive Infraprojects	Rohtak	A			
					PAVITRA INDUSTRIES	HYDERABAD	A		GALVANISATION TO BE DONE FROM GURPREET GALVANIZERS HYDERABAD	

42	**Lighting Mast with raise & Lower Type Lantern Carriage / Polygonal Poles**	**CAT I**								
					Bajaj	Pune	A			
					BP Projects	Kolkata	A			
					Skipper	Howrah	A			
					Transrail Lighting	Silvassa	A			
42.1	**Lighting poles- Tubular/ polygonal**	**CAT I**			Main contractor approved souces having BIS Licensee/ ISI marked with CML Number					
42.2	**Lighting fixtures with accessories (Filament type)**	**CAT I**								
					Crompton	Mumbai	A			
					Bajaj Electricals	Mumbai	A			
					Philips	Noida	A			
					Wipro	Mumbai	A			
					Surya Roshni	Noida	A			
42.3	**Lighting fixtures with accessories (LED type)**	**CAT I**								
					Wipro	Pune	A			
					Surya Roshni	Noida	A			
					Bajaj	Mumbai	A			
					Philips	Noida	A			
					Pyrotech	Udaipur	A			
					Mika	Thane	A			
42.4	**LED Aviation Obstruction Lights**	**CAT I**								
					Instapower	Roorkee	A		Medium and High Intensity	

Note - 1 : Vendors to submit project specific documents as per Sub-QR requirements in case the Vendor is approved under collaboration agreement.

Note - 2: Vendors under 'A' are approved and accepted by NTPC with/without conditions in the past. Similar conditions as the case may be for the vendor shall be applicable for this project and tied up in the quality plan.

Note - 3: Main contractor approved sub vendors are acceptable those are evaluated / assesesed as per Main contractor Quality Management System for vendor approval. Main contractor to inform the finaly selected vendor to NTPC as soon as PO is placed for these items. In case of sub-QR Note-1 is also applicable.

Note - 4 : BOI shall be reviewed and finalised during MQP approval for items/systems where ever applicable.

Note - 5: Category of inspection for LT Cables:

For Total Contract Quantity per Size	*Category Of Inspection*
For cable total quantity ≤ 2.5 KM	Cat-III - submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years

	For cable total quantity above 2.5 km & up to ≤ 10 km per size/type	Cat-II for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
	For cable total quantity 10 km and above per size/type	Cat-I

Note - 6: Category of inspection for Cable Trays & Cable Tray Flexible Support System:

	For Total Contract Quantity per Size	***Category of Inspection***
	For cable total quantity ≤ 2.5 KM	Cat-III - submission of TC & Certificate of Conformance by Main Contractor for the manufacturers having successfully supplied to any NTPC project-site through
	For cable total quantity above 2.5 km & up to ≤ 10 km per size/type	Cat-II for the manufacturers having successfully supplied to any NTPC project-site through Corporate contracts for atleast 2 years
	For cable total quantity 10 km and above per size/type	Cat-I

Note - 7:

i) For Motors less than 50 KW: CAT-III. Acceptance of Motor less than 50 KW is based on COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate and tested in accordance with approved drawing /data sheets".

ii) For Motors 50 KW and less than 75 KW : CAT- II. Acceptance of Motor is based on NTPC review of Routine Test inspection report as per **IS: 12615** / applicable standards duly witnessed by main contractor along with COC of the Manufacturer and the Main Contractor confirming as follows: "It is hereby confirmed that the above mentioned motor /motors was/ were manufactured taking care of NTPC specific requirements regarding ambient temp., voltage & frequency variation, hot starts, pull out torque, starting KVA/KW, temp. rise, distance between centre of stud & gland plate, space heater and tested in accordance with approved drawing /data sheets".

iii) For Motors 75 KW & above : CAT- I . AS PER NTPC APPROVED QUALITY PLAN (To be submitted seperately for NTPC review & approval).

Note - 8: NTPC approved Galvanizers:

	1. M/s M J Engg,Delhi	7. M/s National Galvanizer, Kolkata	13. M/s Gurpreet Galvanizer, Hyderabad	19. Unitech Fabricators & Galvanizers- Hoogly
	2. M/s A.V. Engg, Kolkata	8. M/s Unistar Galvanizer, Kolkata	14. M/s Sigma, Mumbai	
	3. M/s Inar Profiles, Vishakapatnam	9. M/s B.P. Project. Kolkata	15. M/s Radhakrishnan Shetty, Chennai	
	4. M/s Anand Udyog, Mumbai	10. M/s Bajaj Pune	16. Karamtara Mumbai	
	5. M/s Techno Engg,Chandigarh	11. M/s Electrocare Industries, Mumbai	17. Poona Galvanizers Pune	
	6. M/S Steelite Engg, Mumbai	12. M/s B.G. Shirke, Pune	18. Neha Galvanizer- Kolkata	

Note - 9: Relevant certificates shall be submitted for NTPC approval. Approval conditions attached to above identified vendors, as applicable shall be adhered to.

Note - 10 : Indigenous sub-vendors for Annexure-I items are acceptable subject to meeting the MLC (Minimum Local Content) in line with latest MOP order.

LEGENDS / **संकेतिका**

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY /**प्रणाली आपूर्तिकर्ता / सब -वेंडर की स्वीकृति की स्थिति की श्रेणी** (SHALL BE FILLED BY NTPC **एनटीपीसी द्वारा भरा जाएगा**)

ITEM CODE	MAIN VENDOR	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR C	VENDOR NAME	ADDRESS	REMARKS
ES5	STATION LIGHTING	ACDB/ DCDB FIXED TYPE	1	EC05	ELECTRO CONTROLS & DEVICES	M/S ELECTRO CONTROLS & DEVICES, F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA UTTAR PRADESH :201309	
		ACDB/ DCDB FIXED TYPE	2	J01	JASPER ENGNIREES PVT. LTD.	A-23, SECTOR - 8, NOIDA-201301	
		ACDB/ DCDB FIXED TYPE	3	JC01	JACKSON ENGINNEERS	A-43, HOSEIRY COMPLEX, OPPOSITE NSEZ, NOIDA-201305	
		ACDB/ DCDB FIXED TYPE	4	S02	SPACEAGE SWITCHGEARS LTD.	68 & 13-A INDUSTRIAL DEVELOPMENT COLONY, MEHRAULI ROAD GURGAON, HARYANA-122001	
		ACDB/ DCDB FIXED TYPE	5	KM1	KMG ATOZ SYSTEMS	C-49, SECTOR-81-NOIDA-201305	
		ACDB/ DCDB FIXED TYPE	6	E1019	ASIATIC	A-58 NARAINA IND. AREA, PHASE-I , NEW DELHI 110028	
		ACDB/ DCDB FIXED TYPE	7	E05	UNILEC ENGINEERS PVT. LTD.	BEHRAMPUR INDUSTRIAL AREA, BEGAMPUR KHATOLA ROAD, GURGAON-122001	
		ACDB/ DCDB FIXED TYPE	8	C01	C&S ELECTRIC LTD.	222, OKHLA IND. ESTATE, PH-III, NEW DELHI-110020	
		ACDB/ DCDB FIXED TYPE	9	E1210	ENPRO ENGG.	NO.995P, DIAMOND PLAZA, 2ND FLOOR, 12TH MAIN ROAD, ANNA NAGAR, CHENNAI-40	
		ACDB/ DCDB FIXED TYPE	10	A01	ASSOCIATED SWGR & PROJ. LTD.	C-10, UPSIDC, INDUSTRIAL AREA, SITE-IV, KASNA ROAD, GREATER NOIDA-201306	
		ACDB/ DCDB FIXED TYPE	11	B04	BCH	20/4, MATHURA ROAD, FARIDABAD, HARYANA-121006	
		ACDB/ DCDB FIXED TYPE	12	E1043	ECS PRIVATE LTD	7/47, Site 2, Upsidc Ind Area, Loni Road, MOHAN Nagar, Ghaziabad, Uttar Pradesh 201007	
		ACDB/ DCDB FIXED TYPE	13	L01	LK (Formerly L&T)	Lauritz Knudsen Electrical & Automation A/600, SHIL – Mahape Road, TTC Industrial Area, MIDC Thane, Mumbai, Maharashtra 400710	
		ACDB/ DCDB FIXED TYPE	14	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	
		ACDB/ DCDB FIXED TYPE	15	S01	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	
		ACDB/ DCDB FIXED TYPE	16	E1080	KHOKHAR ELECT. PVT LTD.	C-44, SEC-63, NOIDA-201307	
		ACDB/ DCDB FIXED TYPE	17	VC01	VIDHYUT CONTROLS (INDIA) PVT. LTD.	M/S VIDHYUT CONTROL (I) PVT.LTD. D-12 & 13, SECTOR-17,KAVI NAGAR INDL.AREA,GHAZIABAD – 201002 (DELHI NCR) U.P. INDIA	
ES16	STATION LIGHTING	GI CONDUITS	BIS APPROVED MAKE				
ES17	STATION LIGHTING	GI CONDUIT (EPOXY PAINTED)	BIS APPROVED MAKE				
ES18	STATION LIGHTING	FLEXIBLE CONDUITS (LEAD COATED)	1	P03	PLICA INDIA PVT. LTD.	V.P.AGARWAL MANAGING DIRECTOR, PLICA INDIA PVT. LTD. 149, MODEL TOWN EAST	
ES19	STATION LIGHTING	FLEXIBLE CONDUIT (PVC COATED)	REPUTED MAKE				
ES27	STATION LIGHTING	EMER. PORTABLE LTG. SET	1	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		EMER. PORTABLE LTG. SET	2	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
ES32	STATION LIGHTING	HIGH MAST	1	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		HIGH MAST	2	TL01	M/S TRANSRAIL LIGHTING LIMITED (TLL)	M/S TRANSRAIL LIGHTING LIMITED (TLL), GAMMON INDIA LIMITED 2ND FLOOR , CENTRIC PLAZA, PLOT NO.8 POCKET-4, SECTOR-11	
		JUNCTION BOXES (NON FLAME PROOF)	1	J01	JASPER ENGNIREES PVT. LTD.	A-23, SECTOR - 8, NOIDA-201301	
		JUNCTION BOXES (NON FLAME PROOF)	2	EC05	Electro Controls & Devices	M/S ELECTRO CONTROLS & DEVICES, F-41, SITE-C, SURAJPUR INDUSTRIAL AREA GREATER NOIDA, UTTAR PRADESH :201308	

		JUNCTION BOXES (NON FLAME PROOF)	3	SRC01	M/s Shrenik & Co.	39A/3, PANCHRATNA INDUSTRIAL ESTATE, SARKHEJ-BAVLA ROAD, CHANGODAR, AHMEDABAD – 382 213	
		JUNCTION BOXES (NON FLAME PROOF)	4	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		JUNCTION BOXES (NON FLAME PROOF)	5	ACE01	Adroit Control Engineers Pvt.Ltd.	M/S ADROIT CONTROL ENGINEERS PVT.LTD. PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	
		JUNCTION BOXES (NON FLAME PROOF)	6	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
ES36	STATION LIGHTING	JUNCTION BOXES (NON FLAME PROOF)	7	MK01	MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	TYPE-S ONLY
		JUNCTION BOXES (NON FLAME PROOF)	8	PME-01	M/s PHOENIX MECANO LTD.,	388 BHARE, TALUKA MULSHI, POST GHOTAWADE, PIRANGOOT, INDUSTRIAL AREA, PUNE-412115	
		JUNCTION BOXES (NON FLAME PROOF)	9	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B 4	
		JUNCTION BOXES (NON FLAME PROOF)	10	A03	AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
		JUNCTION BOXES (NON FLAME PROOF)	11	SB02	S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	
		JUNCTION BOXES (NON FLAME PROOF)	12	RT13	RITTAL INDIA PVT. LTD.	Espire Building ,Level -1 A-41, Mohan Co-Operative Industrial Estate ,Mathura Road, New Delhi -110044	
		JUNCTION BOXES (NON FLAME PROOF)	13	HP08	HPL ELECTRIC AND POWER LTD.	Works Address: Village Shavella, PO:Jabli, Teh-Kasauli, Dist-Solan, Himachal Pradesh-173209	
ES37	STATION LIGHTING	JUNCTION BOXES (FLAME PROOF)	1	SS01	SUDHIR SWITCHGEAR	305/6, APEEJAY HOUSE, 130, BOMBAY SAMACHAR MARG, MUMBAI - 400 023. INDIA	
		LIGHTING DISTRIBUTION BOARDS	1	E1007	ADVANCE ENGG. COMPANY	38,SETHI IND. ESTATE 10/E,SUREN RD,ANDHERI MUMBAI-400097	
		LIGHTING DISTRIBUTION BOARDS	2	STRG01	Sterling Generators Pvt. Ltd.	C-56/38, INSTITUTIONAL AREA, SECTOR-62, NOIDA -201307, U.P.	
		LIGHTING DISTRIBUTION BOARDS	3	E1091	MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	
		LIGHTING DISTRIBUTION BOARDS	4	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		LIGHTING DISTRIBUTION BOARDS	5	KM1	KMG ATOZ SYSTEMS	"ATOZ HOUSE" C-49, SECTOR-81, GAUTAM BUDDH NAGAR, NOIDA – 201 305 U. P. (INDIA)	
		LIGHTING DISTRIBUTION BOARDS	6	E05	UNILEC ENGINEERS PVT. LTD.	BEHRAMPUR INDUSTRIAL AREA, BEGAMPUR KHATOLA ROAD, GURGAON-122001	
		LIGHTING DISTRIBUTION BOARDS	7	AVA01	AVAIODS TECHNOVATORS LTD.	PLOT NO.25 ,SECTOR-3,IMT-MANESAR, GURGEON-122050 (HARYANA)	
		LIGHTING DISTRIBUTION BOARDS	8	ACE01	Adroit Control Engineers Pvt.Ltd.	M/S ADROIT CONTROL ENGINEERS PVT.LTD. PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	
ES38	STATION LIGHTING	LIGHTING DISTRIBUTION BOARDS	9	JC01	JACKSON ENGINNEERS	A-43, HOSEIRY COMPLEX, OPPOSITE NSEZ, NOIDA-201305	
		LIGHTING DISTRIBUTION BOARDS	10	ADL01	Adlec Systems Private Limited	PLOT NO-277, SWARN PARK, UDYOG NAGAR, MUNDKA, MAIN ROHTAK ROAD, UDYOG NAGAR, NEW DELHI, DELHI 110041	
		LIGHTING DISTRIBUTION BOARDS	11	POP01	Popular Switchgears Pvt Ltd	712, ARUN CHAMBERS, TARDEO MAIN ROAD, TARDEO, NEAR TARDEO AIRCONDITIONER MARKET, MUMBAI - 400034	
		LIGHTING DISTRIBUTION BOARDS	12	CS01	CANDS	J/202, ANSA INDUSTRIAL ESTATE, SAKI VIHAR ROAD, SAKINAKA, ANDHERI (EAST), MUMBAI-72	
		LIGHTING DISTRIBUTION BOARDS	13	PYRE01	Pyrotech Electronics Pvt. Ltd.	M/s Pyrotech Electronics Pvt. Ltd(Unit -1) Led Light, Sensor Division F-16A, Road No.3 Mowar Industrial Area, Madri	
		LIGHTING DISTRIBUTION BOARDS	14	PCS01	Positronics Pvt. Ltd.	POSITRONICS HOUSE ,882/ 2, G.I.D.C. MAKARPURA,VADODARA 390010 GUJARAT	
		LIGHTING DISTRIBUTION BOARDS	15	ISC01	Industrial Switchgears & Control Pvt Ltd	S-02 AMARDEEP MAHAL, NANDA PATKAR RD, VILE PARLE EAST, MUMBAI - 400057	
		LIGHTING DISTRIBUTION BOARDS	16	VC01	M/s Vidhyut Control (I) Pvt.Ltd.	D-12 & 13, SECTOR-17, KAVI NAGAR INDL.AREA, GHAZIABAD – 201002 (DELHI NCR) U.P. INDIA	

		LIGHTING DISTRIBUTION BOARDS	17	MIL01	MILESTONE SWITCHGEARS PVT. LTD.	MILESTONE SWITCHGEARS PVT. LTD. 97, UDYOG VIHAR, PHASE-1, GURGEON HARYANA - 122016	
ES41	STATION LIGHTING	LIGHTING FIXTURES (FLAME PROOF)	1	HI01	HAVELLS INDIA LIMITED	QRG TOWERS , 2D SECTOR-126, NOIDA- 201301	
		LIGHTING FIXTURES (FLAME PROOF)	2	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		LIGHTING FIXTURES (FLAME PROOF)	3	E1206	BALIGA ELECTRICALS	63A,CP RAMASWAMY ROAD, PB NO 6910, CHENNAI-600018	
ES42	STATION LIGHTING	LIGHTING LAMP (NON LED)	1	WP01	WIPRO LTD.	WIPRO CONSUMER CARE AND LIGHTING, 5TH FLOOR, GODREJ ETERNIA -C, OLD PUNE-MUMBAI ROAD, SHIVAJINAGAR, PUNE -411005	
		LIGHTING LAMP (NON LED)	2	E1050	ESSEN DEINKI	FLAT NO. 502, SKYLINE HOUSE 85, NEHRU PLACE NEW DELHI	
		LIGHTING LAMP (NON LED)	3	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		LIGHTING LAMP (NON LED)	4	INS1	INSTA POWER	PLOT NO. - 457 PHASE - V, UDYOG VIHAR, GURGAON - 122016	
		LIGHTING LAMP (NON LED)	5	P01	PHILIPS	9TH FLOOR,DLF 9B, DLF CYBER CITY, DLF PHASE-III,GURGAON-122002	
		LIGHTING LAMP (NON LED)	6	HI01	HAVELLS INDIA LIMITED	QRG TOWERS , 2D SECTOR-126, NOIDA- 201301	
		LIGHTING LAMP (NON LED)	7	HP01	HPL	M/S HPL ELECTRIC & POWER PVT. LTD. PLOT NO. 76-B,PHASE-IV, SEC-57, HSIIDC, INDL. AREA , KUNDLI, DIST. - SONEPAT (HARYANA) - 131028	
		LIGHTING LAMP (NON LED)	8	SR01	SURYA ROSHNI LIMITED	PADMA TOWER, RAJENDRA PLACE, RAJENDRA PLACE NEW DELHI	
		LIGHTING LAMP (NON LED)	9	HN13	M/s Halonix Technologies Limited	M/s Halonix Technologies Limited B-31 , Phase –II, Noida Distt. Gautam Budh Nagar (U.P.) Pin - 201305	
ES43	STATION LIGHTING	LIGHTING LAMP (LED)	1	NE01	Neev Luminaries	D-115 , OKHLA INDUSTRIAL AREA, PHASE-1 NEW DELHI – 110020	
		LIGHTING LAMP (LED)	2	HI01	HAVELLS INDIA LIMITED	QRG TOWERS , 2D SECTOR-126, NOIDA- 201301	
		LIGHTING LAMP (LED)	3	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		LIGHTING LAMP (LED)	4	SR01	SURYA ROSHNI LIMITED	PADMA TOWER, RAJENDRA PLACE, RAJENDRA PLACE NEW DELHI	
		LIGHTING LAMP (LED)	5	P01	PHILIPS	9TH FLOOR,DLF 9B, DLF CYBER CITY, DLF PHASE-III,GURGAON-122002	
		LIGHTING LAMP (LED)	6	HP01	M/S HPL ELECTRIC & POWER PVT. LTD	M/S HPL ELECTRIC & POWER PVT. LTD. PLOT NO. 76-B,PHASE-IV, SEC-57, HSIIDC, INDL. AREA , KUNDLI, DIST. - SONEPAT (HARYANA) - 131028	
		LIGHTING LAMP (LED)	7	INS1	INSTA POWER	PLOT NO. - 457 PHASE - V, UDYOG VIHAR, GURGAON - 122016	
		LIGHTING LAMP (LED)	8	PT13	Pyrotech Electronics Pvt. Ltd.	M/s Pyrotech Electronics Pvt. Ltd(Unit -1) Led Light, Sensor Division F-16A, Road No.3 Mewar Industrial Area, Madri	
		LIGHTING LAMP (LED)	9	HN13	M/s Halonix Technologies Limited	M/s Halonix Technologies Limited B-31 , Phase –II, Noida Distt. Gautam Budh Nagar (U.P.) Pin - 201305	
ES44	STATION LIGHTING	LIGHTING POLES	1	E1033	BOMBAY TUBE & POLES CO.	BOMBAY TUBES & POLES CO. 2ND LANE, DARUKHANA, PLOT NO. 100, MAZGAON, MUMBAI - 10	
		LIGHTING POLES	2	E1118	RIDHDHI POLES	4/5 INDUSTRIAL ESTATE, GORWA, VADODRA-390016	
		LIGHTING POLES	3	MK01	MIKA ENGINEERS	BRANCH OFFICE : 'D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054. WORKS :	
		LIGHTING POLES	4	K02	KL INDUSTRIES	B1 1001 LOK GAURAV, LBS MARG, VIKHROLI WEST, MUMBAI - 400083	
		LIGHTING POLES	5	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4	
		LIGHTING POLES	6	TL01	TLL	M/S TRANSRAIL LIGHTING LIMITED (TLL), GAMMON INDIA LIMITED 2ND FLOOR , CENTRIC PLAZA, PLOT NO.8 POCKET 4, SECTOR 11	

ES45	STATION LIGHTING	LIGHTING SWITCH , SOCKET & S/F UNIT	1	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		LIGHTING SWITCH , SOCKET & S/F UNIT	2	E1012	ANCHOR	STEEL HOUSE, B WING, PLOT NO. 24, MAHAL INDUSTRIAL ESTATE, MAHAKALI CAVES ROAD, NEAR PAPER BOX, ANDHERI (E), MUMBAI, MAHARASHTRA.- 400093	
		LIGHTING SWITCH , SOCKET & S/F UNIT	3	E1076	KAYCEE	KAYCEE INDUSTRIES LTD., C/O-CMS COMPUTERS LTD., 35A, REAR BLDG., KILOKARI, NEW DELH1-110014	
		LIGHTING SWITCH , SOCKET & S/F UNIT	4	L01	LK (Formerly L&T)	Lauritz Knudsen Electrical & Automation A/600, SHIL – Mahape Road, TTC Industrial Area, MIDC Thane, Mumbai, Maharashtra 400710	
		LIGHTING SWITCH , SOCKET & S/F UNIT	5	S01	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	
		LIGHTING SWITCH , SOCKET & S/F UNIT	6	E1068	INDO ASIAN	B-24, PHASE - II , NOIDA - 201305, U.P.	
ES46	STATION LIGHTING	LIGHTING TRANSFORMER	1	E1021	AUTOMATIC ELECTRIC LTD.	ADDRESS : 96 AB LONAVLA INDUSTRIAL ESTATE NANGARGAON, LONAVLA-410401	
		LIGHTING TRANSFORMER	2	E1066	INDCOIL	PLOT NO. A- 150/ 151, 23RD U ROAD, WAGLE ESTATE, THANE WEST, CST RD, FRIENDS COLONY, HALLOW PUL, KURLA WEST, MUMBAI, MAHARASHTRA 400070	
		LIGHTING TRANSFORMER	3	E1103	POWER PACK ENTERPRISES	POWER PACK ENTERPRISES MR. NEHAL SHAH / MR. SHARAD SHAH (PARTNER) NO. 3, JAYSHREE SADAN, 1ST FLOOR, OLD NAGARDAS ROAD, ANDHERI EAST MUMBAI - 400069. MAHARASHTRA. INDIA	
		LIGHTING TRANSFORMER	4	E1155	VIJAY ELECTRICALS LTD.	6-3-648/1&2, OFF RAJ BHAVAN ROAD, SOMAJIGUDA, HYDERABAD - 500 082. ANDHRA PRADESH, INDIA.	
		LIGHTING TRANSFORMER	5	E1057	GILBERT & MAXWELL	WORKS PLOT G-28 , M.I.D.C., AMBAD NASHIK - 422010, MAHARASHTRA, INDIA	
		LIGHTING TRANSFORMER	6	K18	KAPPA ELECTRICALS	KAPPA ELECTRICALS, KAPPA CONSOLIDATED PVT. LTD., SOUTHERN ELECTRIKS 14, CART TRACK ROAD, MADHAVANKARAI, CHENNAI - 600 042. INDIA	
		LIGHTING TRANSFORMER	7	AIE01	Ames Impex Electricals Pvt. Ltd	C-1B/1207, PHASE IV, GIDC NARODA, AHMEDABAD, GUJARAT 382330	
		LIGHTING TRANSFORMER and Control transformer	1	GPID01	Gujarat Plug - In Devices Pvt Ltd.	565, Village - Latipura, Taluka – Padra, Vadodra – 391440	Registered on 08.08.14, renewed on 15.04.24
ES49	STATION LIGHTING	LIGHTING PANEL (FLAME PROOF)	1	E1206	BALIGA ELECTRICALS	63A,CP RAMASWAMY ROAD, PB NO 6910, CHENNAI-600018	
		LIGHTING PANEL (FLAME PROOF)	2	SS01	SUDHIR SWITCHGEAR	305/6, APEEJAY HOUSE, 130, BOMBAY SAMACHAR MARG, MUMBAI - 400 023. INDIA	
ES50	STATION LIGHTING	LIGHTING PANEL (NON FLAME PROOF)	1	E1091	MIKA ENGINEERS	D'-101, DHEERAJ HERITAGE RESIDENCY II, SHASTRI NAGAR, SANTACRUZ (W), MUMBAI 400 054.	
		LIGHTING PANEL (NON FLAME PROOF)	2	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		LIGHTING PANEL (NON FLAME PROOF)	3	VC01	Vidhyut Controls (India) Pvt. Ltd.	M/S VIDHYUT CONTROL (I) PVT.LTD. D-12 & 13, SECTOR-17,KAVI NAGAR INDL.AREA,GHAZIABAD – 201002 (DELHI NCR) U.P. INDIA	
		LIGHTING PANEL (NON FLAME PROOF)	4	KM1	KMG ATOZ SYSTEMS	"ATOZ HOUSE" C-49, SECTOR-81, GAUTAM BUDDH NAGAR, NOIDA – 201 305 U. P. (INDIA)	
		LIGHTING PANEL (NON FLAME PROOF)	5	E05	UNILEC ENGINEERS PVT. LTD.	BEHRAMPUR INDUSTRIAL AREA, BEGAMPUR KHATOLA ROAD, GURGAON-122001	
		LIGHTING PANEL (NON FLAME PROOF)	6	AVA01	AVAIODS TECHNOVATORS LTD.	PLOT NO.25 ,SECTOR-3,IMT-MANESAR, GURGEON-122050 (HARYANA)	
		LIGHTING PANEL (NON FLAME PROOF)	7	ACE01	Adroit Control Engineers Pvt.Ltd.	M/S ADROIT CONTROL ENGINEERS PVT.LTD. PLOT-3, KRISHNA INDL. AREA, SECTOR-25 FARIDABAD – 121004	
		LIGHTING PANEL (NON FLAME PROOF)	8	JC01	JACKSON ENGINNEERS	A-43, HOSEIRY COMPLEX, OPPOSITE NSEZ, NOIDA-201305	
		LIGHTING PANEL (NON FLAME PROOF)	9	MIL01	MILESTONE SWITCHGEARS PVT. LTD.	MILESTONE SWITCHGEARS PVT. LTD. 97, UDYOG VIHAR, PHASE-1, GURGEON HARYANA - 122016	
		LIGHTING PANEL (NON FLAME PROOF)	10	PCS01	Positronics Pvt. Ltd.	POSITRONICS HOUSE ,882/ 2, G.I.D.C. MAKARPURA,VADODARA 390010 GUJARAT	
		LIGHTING PANEL (NON FLAME PROOF)	11	PYRE01	Pyrotech Electronics Pvt. Ltd.	M/s Pyrotech Electronics Pvt. Ltd(Unit -1) Led Light, Sensor Division F-16A, Road No.3 Mewar Industrial Area, Madri	
		MODULAR SWITCH BOARD	1	E1012	ANCHOR	STEEL HOUSE, B WING, PLOT NO. 24, MAHAL INDUSTRIAL ESTATE, MAHAKALI CAVES ROAD, NEAR PAPER BOX, ANDHERI (E), MUMBAI, MAHARASHTRA.- 400093	

ES55	**STATION LIGHTING**	MODULAR SWITCH BOARD	2	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		MODULAR SWITCH BOARD	3	HI01	HAVELLS INDIA LIMITED	QRG TOWERS , 2D SECTOR-126, NOIDA- 201301	
ES59	**STATION LIGHTING**	RECEPTACLES - DECORATIVE	1	E1012	ANCHOR	STEEL HOUSE, B WING, PLOT NO. 24, MAHAL INDUSTRIAL ESTATE, MAHAKALI CAVES ROAD, NEAR PAPER BOX, ANDHERI (E), MUMBAI, MAHARASHTRA.- 400093	
		RECEPTACLES - DECORATIVE	2	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		RECEPTACLES - DECORATIVE	3	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B 4	
		RECEPTACLES - DECORATIVE	4	A03	AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
ES61	**STATION LIGHTING**	SWITCH BOX	1	E1012	ANCHOR	STEEL HOUSE, B WING, PLOT NO. 24, MAHAL INDUSTRIAL ESTATE, MAHAKALI CAVES ROAD, NEAR PAPER BOX, ANDHERI (E), MUMBAI, MAHARASHTRA.- 400093	
		SWITCH BOX	2	F04	ELEXPRO ELECTRICALS PVT/ LTD.	C 1/27 & 37 GIDC KABILPORE NAVSARI-396424	
		SWITCH BOX	3	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B 4	
		SWITCH BOX	4	A03	AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
		SWITCH BOX	5	SB02	S.B. ELECTRICAL ENGINEERING CORPORATION	03, SARDAR GRIHA BUILDING, LOHAR CHAWAL, MUMBAI-400002	
ES67	**STATION LIGHTING**	RECEPTACLE (FLAME PROOF)	1	E1206	BALIGA ELECTRICALS	63A,CP RAMASWAMY ROAD, PB NO 6910, CHENNAI-600018	
		RECEPTACLE (FLAME PROOF)	2	SS01	SUDHIR SWITCHGEAR	305/6, APEEJAY HOUSE, 130, BOMBAY SAMACHAR MARG, MUMBAI - 400 023. INDIA	
		RECEPTACLE (FLAME PROOF)	3	FFP01	FCG FLAME PROOF CONTROL GEAR	A1/53, SHAH & NAHAR INDUSTRIAL ESTATE, SITARAM JADHAV ROAD, LOWER PAREL (W), MUMBAI-400 013	
ES68	**STATION LIGHTING**	RECEPTACLE (NON FLAME PROOF)	1	A03	AJMERA INDUSTRIES & ENGG. WORKS	AJMERA INDL. AND ENGG. WORKS. AJMERA HOUSE, A-61 / KHAIRANE MIDC. , TTC INDL. AREA, NAVI MUMBAI – 400705.	
		RECEPTACLE (NON FLAME PROOF)	2	C02	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	
		RECEPTACLE (NON FLAME PROOF)	3	E1207	CYCLO ELECTRIC DEVICE & SERV.CO.	: A-3, NEAR ANTHEM BIOSCIENCE, KSSIDC INDUSTRIAL AREA, BOMMASANDRA, BOMMASANDRA INDUSTRIAL AREA, BANGALORE, KARNATAKA 560099	
		RECEPTACLE (NON FLAME PROOF)	4	B04	BCH	20/4, MATHURA ROAD, FARIDABAD - 121006, HARYANA, INDIA	
		RECEPTACLE (NON FLAME PROOF)	5	B02	BEST & CROMPTON	BEST & CROMPTON ENGINEERING LTD 28C, AMBATTUR INDUSTRIAL ESTATE (NORTH) AMBATTUR, CHENNAI - 600 098	
ES69	**STATION LIGHTING**	EMERGENCY LIGHTING UNIT (FIXED & PORTABLE TYPE)- NON FLAME PROOF	1	B05	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B 4	
		EMERGENCY LIGHTING UNIT (FIXED & PORTABLE TYPE)- NON FLAME PROOF	2	PEP05	PROLITE AUTOGLO LIMITED,	PROLITE AUTOGLO LTD 25 SINGH INDUSTRIAL ESTATE NO. 3, RAM MANDIR ROAD., GOREGAON (W), MUMBAI, MAHARASHTRA 400104, INDIA	
ES70	**STATION LIGHTING**	EMERGENCY LIGHTING UNIT (FIXED & PORTABLE TYPE)- FLAME PROOF	1				
ES71	**STATION LIGHTING**	24V SUPPLY MODULE WITH COMPLETE ACCESSORIES	1	E1103	POWER PACK ENTERPRISES	POWER PACK ENTERPRISES MR. NEHAL SHAH / MR. SHARAD SHAH (PARTNER) NO. 3, JAYSHREE SADAN, 1ST FLOOR, OLD NAGARDAS ROAD, ANDHERI EAST MUMBAI- 400069, MAHARASHTRA, INDIA	
		24V SUPPLY MODULE WITH COMPLETE ACCESSORIES	2	E1066	INDCOIL	ADDRESS: PLOT NO. A- 150/ 151, 23RD D ROAD, WAGLE ESTATE, THANE WEST, CST RD, FRIENDS COLONY, HALLOW PUL, KURLA WEST, MUMBAI, MAHARASHTRA 400070	
		24V SUPPLY MODULE WITH COMPLETE ACCESSORIES	3	AIE01	Ames Impex Electricals Pvt. Ltd	C-1B/1207, PHASE IV, GIDC NARODA, AHMEDABAD, GUJARAT 382330	
ES80	**STATION LIGHTING**	PVC WIRES	BIS APPROVED MAKE				
ES81	**STATION LIGHTING**	PEDESTAL FAN & CEILING FAN	REPUTED MAKE				
ES82	**STATION LIGHTING**	EXIT SIGN (FLAME PROOF)	REPUTED MAKE				

ES83	**STATION LIGHTING**	EXIT SIGN (NON FLAME PROOF)	REPUTED MAKE				
ES84	**STATION LIGHTING**	LADDER	REPUTED MAKE				
ES85	**STATION LIGHTING**	HUME PIPE	REPUTED MAKE				
ES86	**STATION LIGHTING**	PHOTOELECTRIC SWITCH	REPUTED MAKE				
ES87	**STATION LIGHTING**	DICHORIC SPOT LIGHTING FIXTURE	REPUTED MAKE				
ES88	**STATION LIGHTING**	HAND LAMP UNIT	REPUTED MAKE				
ES89	**STATION LIGHTING**	LIGHTING DESIGNER	1	AT13	AVAIDS TECHNOVATORS PVT. LTD.	4A/58, SHANKAR ROAD, NEW DELHI-110060	
		LIGHTING DESIGNER	2	BE13	BAJAJ ELECTRICALS LTD.	801 (8th floor), Rustomjee Aspire, Bhanu Shankar Yagnik Marg, Off Eastern Express Highway Sion (E), Mumbai 400022	
		LIGHTING DESIGNER	3	KS13	KELSATEK SOLUTIONS PVT. LTD.	50/1 4TH FLOOR, CHURCH STREET, BANGALORE-560001	
		LIGHTING DESIGNER	4	SE13	M/s SUMANAM ENGINEERING SERVICES CONSULTANT	1, ADITHYA, KOWDIAR, TRIVANDRUM 695003	
		LIGHTING DESIGNER	5	SM13	SPAN MANUFACTURING COMPANY LTD	27 First Floor, Bhiku Building, Murari Ghag Marg, Prabhadevi, Mumbai-400025	Lighting System designer only for FGD, R&M and Hydro projects
		LIGHTING DESIGNER	6	CL13	CITELUM INDIA PVT. LTD	Y-14A, GREEN PARK MAIN, NEW DELHI-110016	Lighting System designer only for FGD, R&M and Hydro projects
		LIGHTING DESIGNER	7	SR13	M/s SURYA ROSHNI LTD	Padma Tower 1, Rajendra Place, New Delhi–110008	
		LIGHTING DESIGNER	8	HP13	M/s HPL ELECTRIC & POWER PVT. LTD.	WINDSOR BUSINESS PARK, B-1D, SECTOR-10 NOIDA-201301 (UP)	
		LIGHTING DESIGNER	9	ME13	M/s MIKA ENGINEERS.	Survey No.-47,Shed No.-2,Aghai,Shahapur-Wada Road, Village-Aghai, THANE , Pin 421601; MAHARASHTRA	
		LIGHTING DESIGNER	10	FED13	M/s. Forus Electric Pvt. Ltd.	M/s. Forus Electric Pvt. Ltd. B-313, Okhla Industrial Area, Phase-1, New delhi-110020	
		LIGHTING DESIGNER	11	US13	U. S. CONSULTANTS	U. S. CONSULTANTS C-47, SECOND FL. SECTOR -2, NOIDA - 201301	
		LIGHTING DESIGNER	12	PY06	Pyrotech Technologies Pvt. Ltd.	F-16, Road no. 3, Mewar industrial Area, Madri, Udaipur-313003 RJ(IN), Udaipur Industrial Area, Udaipur, Girwa, Rajasthan, India, 313003	

Makes of sub-vendor and equipment/components mentioned in the above lists are indicative and shall be subject to Customer/BHEL approval. The bidder may propose name of additional sub-vendors makes based on their experience, which will be subject to Customer/BHEL approval.