HARYANA POWER GENERATION CORPORATION LIMITED (HPGCL)

1X800 MW SUPER CRITICAL EXPANSION UNIT
DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT
YAMUNA NAGAR, HARYANA

TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER (NDCT)

BOOK 1 OF 2

(MECHANICAL, ELECTRICAL AND C&I SPECIFICATION)

SPECIFICATION No. **PE-TS-510-165-W001**
REV NO. 01

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

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PROJECT INFORMATION

SL.NO	DESCRIPTION	DETAILS
1	**METEOROLOGICAL DATA**	
1.1	MAXIMUM TEMPERATURE	REFER CLIMATOLOGICAL TABLE ENCLOSED IN SPECIFICATION STATION-AMBALA
1.2	MINIMUM TEMPERATURE	
1.3	MAXIMUM RELATIVE HUMIDITY	
1.4	MINIMUM RELATIVE HUMIDITY	
1.5	AVERAGE ANNUAL RAINFALL	
2	**ELECTRICAL DATA**	
2.1	AMBIENT TEMPERATURE FOR DESIGN OF ELECTRICAL	50 deg C
2.2	RATED FREQUENCY	50 Hz
2.3	FREQUENCY VARIATION	(+)5% 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)	15 kA $$ for 1 second
	Note: $$ denotes fault level at DCDB level shall be 15kA while at DLDB level fault level shall be 10kA.	
3	**SITE LOCATION:**	
	The proposed site for this expansion Unit is in the already acquired premises of existing 2x300 MW Units at DCRTPP, Yamuna Nagar.	
	Place	Kalanaur
	District	Yamuna Nagar
	State	Haryana
	Country	India
	Latitude & Longitude of project site	North: 30º 06’ 34” N East: 77º 19’ 43” E
	Nearest Railway Station	Kalanaur, 2 km
	Nearest Town	Yamuna Nagar, 8 km
	Nearest Highway	National Highway - 344
	Nearest Airport	Chandigarh, 110 km
	Nearest Water Body	Western Yamuna Canal, adjacent to site
4	**GRADE LEVEL:** For NDCT Area, Finished Graded Level (FGL) shall be R.L. (+) 270.0M 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 LOAD:** REFER CIVIL SPECIFICATION BOOK 2 OF 2.	
8	**GENERAL INFORMATION:**	
	Land for labour colony, laydown area for storage of equipment, fabrication yard or any other construction related activities is not available within the plant boundary. Bidder has to make his own arrangement to have these facilities outside plant boundary. Disposal and cleaning of all construction debris inside the plant boundary and facilities of bidder outside plant boundary are included in bidder’s scope.	

जलवायवी सारणी

CLIMATOLOGICAL TABLE

स्टेशन : अम्बाला STATION : Ambala | अक्षांश LAT. 30° 23' | देशान्तर LONG. 76° 46' | समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 272 मीटर METRES | प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1981-2010

माह MONTH		स्टेशन का वायुदाब STATION LEVEL PRESSURE एक.मी.ए. hPa	वायु तापमान AIR TEMPERATURE माध्य MEAN शुष्क बल्ब DRY BULB डि. से °C	नम बल्ब WET BULB डि. से °C	दैनिक अधिकतम का माध्य DAILY MAX डि. से °C	दैनिक न्यूनतम का माध्य DAILY MIN डि. से °C	माह में उच्चतम का माध्य HIGHEST IN THE MONTH डि. से °C	माह में निम्नतम का माध्य LOWEST IN THE MONTH डि. से °C	चरम EXTREMES उच्चतम HIGHEST डि. से °C	दिनांक और वर्ष DATE AND YEAR	निम्नतम LOWEST डि. से °C	दिनांक और वर्ष DATE AND YEAR	आर्द्रता HUMIDITY सापेक्ष आर्द्रता RELATIVE HUMIDITY प्रतिशत %	वाष्प दाब VAPOUR PRESSURE एक.मी.ए. hPa	मेघ की मात्रा CLOUD AMOUNTS समस्त मेघ ALL CLOUDS आकाश के अष्टमांश Oktas of sky	निम्न मेघ LOW CLOUDS	मासिक योग MONTHLY TOTAL मि.मी. mm	वर्षा के दिनों की संख्या NO. OF RAINY DAYS	वर्षा RAINFALL सर्वाधिक नम महीने का योग TOTAL IN WETTEST MONTH WITH YEAR मि.मी. mm	सर्वाधिक शुष्कतम महीने का योग TOTAL IN DRIEST MONTH WITH YEAR मि.मी. mm	24 घंटों की सबसे भारी वर्षा HEAVIEST FALL IN 24 HOURS मि.मी. mm	दिनांक और वर्ष DATE AND YEAR	माध्य पवन गति MEAN WIND SPEED कि.मी. प्र. घ. Kmph
जनवरी JAN	I	994.6	8.6	7.7	18.9	6.4	24.1	2.7	29.1	29 1991	-1.3	24 2008	87	9.9	4.1	2.6	27.3	1.9	152.7 1953	0	118.4	16 1953	3.4
	II	982.8	16.5	12.7									63	11.8	3.1	1.3							
फरवरी FEB	I	982.2	11.7	10.1	22.4	9.1	27.3	5	33.9	28 1956	-0.6	1 1905	81	11.2	3.1	1.3	35.1	2.2	233.9 1898	0	146.8	11 1898	4.7
	II	980.3	20.2	14.9									54	12.8	3	1.1							
मार्च MAR	I	979.6	17.5	14.4	27.8	13.8	33	8.9	41.7	31 1945	3.7	9 1979	70	14	2.8	0.9	27.2	1.8	176 1982	0	103.9	13 1956	5.1
	II	977.3	25.6	18									45	14.7	3.1	1.1							
अप्रैल APR	I	975.8	24.6	18.2	34.9	19.1	40.1	13.7	45	28 1941	9.4	6 1967	51	15.8	2.2	0.6	12.3	1.2	174.4 1983	0	82	6 1935	4.9
	II	973.1	33	20.4									28	14	2.5	0.9							
मई MAY	I	972.2	29.1	21.6	38.1	23.4	42.6	18	47.8	29 1944	13.9	1 2004	50	19.9	1.8	0.6	31.5	2.7	146.7 2008	0	85.1	20 1913	5
	II	968.9	36.3	23.2									31	18	2	0.9							
जून JUN	I	968.6	30.1	24.3	38.1	25.4	42.8	20.3	47.8	17 1923	17.8	5 2000	62	25.9	2.9	1.4	86.6	4.5	291.3 1913	0	121.8	20 1973	5
	II	965.1	36.1	25.4									42	23.9	2.6	1.4							
जुलाई JUL	I	968.3	28.7	26.1	34.4	25.5	38.9	21.8	46.7	10 1903	19.4	5 1956	81	31.8	5.1	2.8	284.7	9.1	715 2010	7.2 1987	206.7	16 2001	4.2
	II	965.5	32.5	27.2									67	31.9	5	3.1							
अगस्त AUG	I	970.4	28	26	33.3	25	36.3	22.2	43.9	7 1918	3.7	11 2010	84	32.1	5.1	2.8	239.2	9	649 2004	1.7 1993	246.2	3 2004	3.4
	II	967.6	31.4	27.3									72	32.9	5.1	3.3							
सितम्बर SEP	I	974.5	26.4	24.2	33.1	23	35.7	19.3	40.6	6 1951	15.6	22 1972	82	28.6	3	1.7	134.8	4.8	631 1962	0	224.8	26 1945	3.5
	II	971.6	30.9	25.6									64	28.6	3	1.9							
अक्तूबर OCT	I	980	21.2	18.5	31.7	17.1	34.6	12.4	39.4	6 1941	8.3	30 1898	76	19.5	0.8	0.3	15.1	0.8	306.5 1955	0	141.6	5 1973	2.6
	II	977.2	28.5	21.5									51	20.1	1	0.4							
नवम्बर NOV	I	983.6	14.5	12.7	27.1	11.1	30.5	6.6	35.6	14 1947	1.8	29 1966	81	13.5	1.2	0.3	4.5	0.6	136.4 1951	0	135.1	26 1951	2.3
	II	981.1	23	17.2									53	15	1.3	0.2							
दिसम्बर DEC	I	985.3	9.5	8.5	21.7	7.1	25.5	3.3	29.4	5 1944	-0.6	27 1913	86	10.4	3	1.6	19.7	1	111.2 1997	0	72.5	10 1997	2.5
	II	983.2	18.1	13.8									60	12.4	2.5	0.8							
वार्षिक योग का माध्य ANNUAL TOTAL OR MEAN	I	977.1	20.8	17.7	30.1	17.2	43.5	2.1	47.8	29	-1.3	24	74	19.4	2.9	1.4	898.2	39.6	2047.7	297.6	246.2	3	3.9
	II	974.5	27.7	20.6					5	1944	1	2008	52	19.7	2.9	1.4			1896	1918	8	2004	
वर्षों की संख्या NUMBER OF YEARS	I		28	28	29	29	29	29	107		107		28	28	28	28	30	30	106	106	108		29
	II																						

जलवायवी सारणी
CLIMATOLOGICAL TABLE

देशज : अम्बाला
STAION : Ambala

माह		मौसम परिघटना						पवन												मेघ								दृश्यता							
		के साथ दिनों की संख्या						पवन की गति के साथ दिनों की संख्या (कि. मी. प्र. घं.)				पवन की दिशा के दिनों की संख्या का प्रतिशत								मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश								निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश								दृश्यता सहित दिनों की संख्या					
		वर्षण 0.3 मि.मि.या अधिक	ओले	गर्जन	कुहासा	धूल भरी आंधी	चंडे गाम	62 या अधिक	20-61	1-19	0	3	उ.	ई.	पू.	द.	दि.	प.	उ.प.	शांत	0	से-2	3-5	6-7	8	धुंधला 9	0	से-2	3-5	6-7	8	धुंधला 9	1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
		WEATHER PHENOMENA						WIND												CLOUD								VISIBILITY							
		No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p.h.)				PERCENTAGE No. OF DAYS WIND FROM								No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) O K T A S								No. OF DAYS WITH LOW CLOUD AMOUNT O K T A S								No. OF DAYS WITH VISIBILITY					
महीना		हिमपात 0.5mm Or more	हिम	गर्जन THUNDER	कुहासा FOG	धूल भरी आंधी DUST STORM	चंडे गाम SQU ALL	62 या अधिक	20-61	1-19	0	उ.	ई.	पू.	द.	दि.	प.	उ.प.	शांत	0	से-2	3-5	6-7	8	धुंधला 9	0	से-2	3-5	6-7	8	धुंधला 9	1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
जनवरी JAN	I	3.3	0.1	1.6	9.6	0.1	0	0	0	12	19	2	0	1	5	0	1	5	22	64	9	3	4	5	10	0	16	3	4	1	7	0	8.6	15.6	6.8	0	0
	II							0	0	20	11	3	0	1	6	0	0	10	46	34	12	4	6	6	3		21	3	5	1	1		1.4	7.7	21.9	0.1	0
फरवरी FEB	I	4	0.3	2.1	1.8	0	0	0	0	14	14	3	1	2	8	1	0	4	29	52	10	4	6	5	3	0	18	3	5	1	1	0	1.6	12.6	13.9	0	0
	II							0	0	23	5	2	0	1	9	2	2	15	50	19	9	5	6	7	1		17	5	5	1	0		0.1	2.4	25.5	0.1	0
मार्च MAR	I	4.4	0.2	3.9	0.2	0.1	0	0	0	18	13	7	1	2	10	1	0	5	33	41	11	5	7	6	2	0	22	3	5	1	0	0	0.3	6.3	24.3	0	0.1
	II							0	0	26	5	2	1	1	8	3	2	15	53	15	8	7	7	7	2		17	7	6	1	0		0	1.3	29.6	0.1	0
अप्रैल APR	I	3.1	0.2	3	0	0.6	0	0	0	18	12	7	1	4	14	1	1	3	28	41	14	5	6	4	1	0	25	2	3	0	0	0	0	3.4	26.4	0.2	0
	II							0	0	25	5	6	1	2	7	2	2	8	55	17	10	7	7	5	1		18	7	4	1	0		0.1	1.9	27.8	0.3	0
मई MAY	I	5	0.2	6.8	0.1	1	0	0	0	21	10	4	1	5	35	2	0	3	17	33	17	4	5	4	1	0	24	3	4	0	0	0	0.1	5	25.8	0.1	0
	II							0	0	24	7	6	1	2	16	4	2	8	39	22	13	7	6	4	1		19	7	4	1	0		0.2	2.8	27.9	0.2	0
जून JUN	I	6.9	0	6.4	0.1	1.1	0	0	0	21	9	6	1	7	33	4	1	4	13	31	13	3	5	6	3	0	17	4	7	2	0	0	0.1	5.8	24.1	0	0
	II							0	0	24	6	4	1	3	17	4	3	13	36	19	12	6	6	5	1		15	7	7	1	0		0.3	3.8	25.8	0.1	0
जुलाई JUL	I	13.2	0	9.4	0	0.3	0	0	0	19	12	2	1	5	38	2	2	3	5	42	3	3	6	13	6	0	8	4	15	4	0	0	0.1	4.3	26.5	0.1	0
	II							0	0	21	10	4	2	4	21	4	2	11	19	33	2	3	10	14	2		3	7	18	3	0		0.1	1.9	28.8	0.3	0
अगस्त AUG	I	13	0	8.6	0.1	0	0	0	0	15	16	2	1	3	27	1	1	6	8	51	3	3	7	12	6	0	7	6	14	4	0	0	0.1	3	27.8	0.1	0
	II							0	0	19	12	4	1	3	14	3	2	12	20	41	1	3	10	15	2		2	6	21	2	0		0	0.6	30.2	0.3	0
सितम्बर SEP	I	7.1	0	4.9	0.4	0.1	0	0	0	14	16	5	1	3	17	1	1	3	15	54	11	4	6	6	3	0	17	4	7	2	0	0	0.1	4	25.7	0.2	0
	II							0	0	21	9	3	1	1	7	1	2	16	40	29	8	7	8	6	1		10	9	10	1	0		0	0.9	29	0.2	0
अक्तूबर OCT	I	1.8	0	1.3	0.4	0.1	0	0	0	9	22	3	1	2	11	1	0	1	10	71	25	2	2	1	1	0	29	1	1	0	0	0	0.3	11.4	19.3	0	0
	II							0	0	12	19	2	0	1	3	0	1	2	31	60	22	4	3	2	0		26	3	2	0	0		0	4	27	0	0
नवम्बर NOV	I	0.9	0	0.8	0.9	0	0	0	0	6	24	1	0	1	4	1	0	1	12	80	20	3	4	2	1	0	28	1	1	0	0	0	0.9	17.4	11.7	0	0
	II							0	0	9	21	0	0	0	1	0	0	1	26	72	20	4	4	2	0		27	2	1	0	0		0	4.3	25.7	0	0
दिसम्बर DEC	I	2	0.2	1.2	6.7	0	0	0	0	7	24	2	1	0	4	0	0	2	16	75	14	3	5	4	5	0	22	2	3	0	4	0	5.9	19.4	5.7	0	0
	II							0	0	13	18	1	0	0	2	0	0	4	34	59	13	5	6	5	2		22	3	4	1	0		0.8	7.4	22.9	0	0
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	64.7	1.2	50.1	20.3	3.2	0	0	0	170	195	4	1	3	17	1	1	3	17	53	155	43	64	64	39	0	233	36	67	16	13	0	17.9	108.4	239.9	0.8	0.1
	II							0	1	238	126	3	1	2	9	2	2	10	36	35	129	64	81	75	16		199	66	87	11	2	0	2.8	38.9	321.8	1.5	0
वर्षों की NUMBER OF YEARS	I	29										29									29						29								
	II																																		

	GENERAL TECHNICAL REQUIREMENT
1	The Design, Manufacture, Inspection & testing, construction and Performance of Cooling Tower complete with all accessories, shall generally conform to the latest editions of the applicable 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 contrdictions between the requirements of two clauses of this specification, documents or requirements of different codes and standards specified, stringent requirement as interpreted by BHEL / Owner shall apply.
5	Bidder to note that drawing/document submissions shall be through web based Document Management System. Bidder will be provided access to the DMS along with adequate training for drg/doc submissions. 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 at 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 including civil works between the terminal points includes all works which are stated or unstated or required as per system as part of complete turnkey package. Only the items specifically mentioned in the exclusion list of works are not in bidder's scope.
9	Scope of works also 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 package within quoted prices. In case this is not clear to bidder, the bidder may seek clarifications for 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 is provided in the 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. Alternate materials offered by bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the bidder and any standard code required for establishing the same shall be in English language. The acceptance of alternate material shall be subjected to Customer/BHEL approval. Materials of construction for components not specified shall be similarly selected by the bidder for the intended duty/fluid and subject to Customer/BHEL approval.
14	Cost of Piling 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	The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by BHEL/Customer. In any case a minimum corrosion allowance of 1.6 mm shall be considered while selecting the thickness.
18	Minimum pipe thickness for overground piping shall be as follows: • 5.4 mm for pipe size upto 150 NB • 6.35 mm for pipe size 200 NB to 300 NB • 7.1 mm for pipe size 350 NB to 450 NB • 8.0 mm for Pipe size 500 NB to 800 NB • 10 mm for Pipe size 900 NB to 1100 NB. • 12 mm for pipe size 1200 NB to 1400 NB. • 14 mm for pipe sizes >1400 NB to 1600 NB • 16 mm for pipe sizes >1600 NB to 2100 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.
19	WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following “C” value. i) Carbon steel pipe - 100 ii) CI Pipe/Ductile Iron - 100 iii) Rubber lined steel pipe - 120 iv) Stainless steel pipe - 100 For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.
20	High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material. Vents shall be of 200mm for line size >=400NB and 50mm for line size < 400NB. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall be of 200mm for line size >=400NB and 50mm for line size < 400NB.
21	Threaded joints shall be provided with teflon sealant tapes.
22	All piping 450 NB & above shall be designated as large dia piping.
23	Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and shall submit the detailed drawings for thrust/anchor block. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.
24	Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).
25	The complete 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/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.

26	Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes. 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.
27	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.
28	The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Technical Data Part-A.
29	Based on the inside diameter so established, thickness calculation shall be made as per ANSI B 31.1. OD and thickness of pipes shall then be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
30	Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
31	Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
32	Piping and fittings shall be manufactured by an approved manufacturer. They shall be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
33	Piping and fittings shall be manufactured by an approved manufacturer. They shall be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents,
34	At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
35	All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
36	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.
37	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.
38	CT basin shall be provided with adequate slope (Min slope of 1:120) towards the sludge sump for drainage purpose.
39	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.
40	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.
41	No wood/ timberwork shall be used in any component of the cooling tower.
42	All parts subjected to periodical maintenance & inspection such as Inlet louvers (if applicable), fills, drift eliminators etc. shall be readily accessible.
43	Access doors shall be provided for entry into cooling water distribution level. The doors shall be easily operable with leak proof design.
44	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.
45	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.
46	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.
47	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.

48	Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.
49	The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.
50	**Proof of Design Test (Type Test) for Butterfly Valves:** Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of BHEL/Customer's representative. All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shaft generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.
51	The Contractor shall guarantee the long term availability of spares to 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.
52	In case of any discrepancy in the requirement 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 BHEL/customer shall prevail without any commercial implication
53	**ELECTRICAL:**
	As per Electrical specification.
54	**CONTROL AND INSTRUMENTATION:**
54.1	Complete Field Intrumentation for monitoring and operation of NDCT package be provided by bidder.
54.2	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.
54.3	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.
54.4	All test instruments required for the Performance Guarantee Test (PG Test) shall be provided by the Bidder. Calibration of test instruments shall be the responsibility of the Bidder.
54.5	Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments shall be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments shall be valid for the period of test.
54.6	List of instruments to be arranged by the Bidder along with the calibration certificates of the instruments to be used, psychometric charts and tables shall be submitted to the Owner/ Consultant for approval in advance.
54.7	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, as applicable shall be provided by bidder.
54.8	All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.
54.9	For other C&I details refer the C&I Specification.

55	**3D MODEL REQUIREMENT:**
55.1	Bidder shall submit 3D Parametric review model of the cooling tower area within terminal points.
55.2	All the layout shall be made in computerized 3D modelling system. The Owner reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Owner's review shall be fully dimensioned and extracted from 3D model after interference check. Following file formats are acceptable: 1. (.dwg) 2. (.dgn) 3. (.ifc) 4. (.nwd) 5. (.dxf)
55.3	All documents submitted by the Contractor for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies. The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.
55.4	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.
55.5	The corresponding complete 3D review model shall also be handed over to the employer for reference after the completion of engineering of respective package.
56	**BID EVALUATION CRITERIA:**
56.1	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.
56.2	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
56.3	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.
56.4	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 specified in the NIT.
56.5	No benefit will be given to Bidder, in case of reduction in actual quantity of Cement and reinforcement steel with respect to the quantities considered in bid evaluation.

TECHNICAL DATA - PART - A (MECHANICAL)

This enquiry covers the complete cooling tower on EPC basis including design, engineering, 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, construction, 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.

It is not the intent to specify herein all the details of design and manufacture/construction/erection. 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	All Cooling Tower related Civil works including Shell, Superstructure, substructure, piling, foundation, grillage work, basin, outlet channels/ sump, sludge pits etc with details as per specification.	Yes, within terminal points
1.2	Cement	No (free issue by BHEL)
1.3	Reinforced Steel	No (free issue by BHEL)
1.4	Structural Steel	Yes
1.5	Fills	Yes
1.6	Drift Eliminators	Yes
1.7	Hot water piping to distribution duct	Yes, within terminal points
1.8	Protection of buried hot water duct	Yes as per painting specification
1.9	Hot water header isolation valves on risers	Yes (Motor operated Butterfly Valves)
1.10	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	Yes
1.11	Screen & guide for each cold water outlet sump/ channel	Yes
1.12	Stop log gate with guides and sealing arrangement for each cold water outlet sump/ channel	Yes
1.13	Isolation valves in sludge pit	Yes
1.14	Submersible Type sludge pumps along with valve (Isolation Valve & NRV) and other accessories	Yes
1.15	Drain Piping from sludge pump to terminal point	Yes, upto terminal point. Further, Piping upto suitable location for disposal shall be provided by BHEL (tentative disposal point may be at a distance of approx. 500 M beyond sludge pipe terminal point). Minimum pump head to be selected 30M.
1.16	Portable type tripod arrangement for handling of sludge pumps (Minimum 1 Ton)	Yes
1.17	Chain Pulley block together with the monorails and supporting frames for the handling of each screen and gates in cold water outlet sump/ channel	Yes (Min. 2 nos.)
1.18	All necessary supports, hangers and anchors	Yes
1.19	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipments supplied	Yes

1.20	Cross over facility, as required, over hot water pipes (applicable as per layout requirement)	Yes
1.21	Paving all around cooling tower periphery	Yes
1.22	Electrical and C&I	Yes as per respective specification
1.23	Mandatory spares	Yes
1.24	Special tools & tackles required for maintenance of equipment & accessories	Yes
1.25	Various drawings, datasheets, calculation, test reports/ certificates, operation & maintenance manuals including “As built drawings” etc. as specified & as necessary.	Yes
1.26	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
1.27	Supply of commissioning spares on as required basis.	Yes
1.28	Any additional system/ equipment required to make the system complete.	Yes
2.0	**Scope of Services**	
2.1	Transportation, delivery, unloading / handling at site and storage at Site	Yes
2.2	Civil & structural works (including piling) at site	Yes
2.3	Erection & Commissioning at site	Yes
2.4	Performance Gaurantee at site	Yes
2.5	Wind tunnel study	Yes
2.6	Any other service required to make the system complete	Yes
3.0	**Terminal Point**	
3.1	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 Hot water Duct in NDCT: e) Isolation M.O BFVs in Individual Hot water riser pipe:	a) Refer Annex-III. (15m away from NDCT basin edge) b) 3840mm X 20 mm thk. c) Refer Annex-III d) Bidder’s scope. e) Bidder's scope
3.2	Electrical	Refer Electrical scope sheet
4.0	**CONSTRUCTION FEATURES FOR EACH COOLING TOWER**	
4.1	Whether fills are easily installable & removable	Yes
4.2	Fills supported by nailing acceptable	No
4.3	Number of RCC stair cases from ground level up to hot water distribution system for maintenance inside the Cooling tower	Minimum Two(2) nos. viz. one at each end.
4.4	Number of cage ladders	Minimum Four (4) Nos.
4.5	Internal walkway of platform with hand rails	Refer Book 2 of 2 (End customer's civil specification)
4.6	External walkway platform	Refer Book 2 of 2 (End customer's civil specification)
4.7	Platform for access and operation of BFV	To be Provided by Bidder
5.0	**Material of construction**	
5.1	Cold water basin, outlet channel/ sump & sludge pit.	R.C.C.
5.2	Shell & Superstructure	R.C.C
5.3	Basin partition walls	R.C.C
5.4	Internal/External walk way & platform	R.C.C

5.5	Staircase	R.C.C
5.6	Access Ladder	Hot dip galvanized mild steel rung ladders with etch primer and bituminous painting
5.7	Hand rails	Stainless steel
5.8	Supporting structures	R.C.C.
5.9	Hot water distribution nozzles (low pressure non clogging)	PVC, Polypropylene UV rays stabilized / Gun metal as per IS 318 Gr VI
5.10	Fills	PVC, Polypropylene UV rays stabilized
5.11	Fill support	RCC
5.12	Louvers (if any)	RCC
5.13	Drift eliminators	PVC, Polypropylene UV rays stabilised
5.14	Doors for access to distribution system	FRP
5.15	Fasteners/wetted parts	Silicone bronze (wet); stainless steel 316 (dry)
5.16	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)
5.17	Hot Water Distribution Pipes (Inside CT)	PVC (IS 4985 Class 3)/FRP/HDPE (IS 4984 PN6, grade PE 80)/or RCC/ pre-cast open trough
5.18	Butterfly Valves: Body & Disc	ASTM A48, Gr. 40 with 2% Ni CI IS 210 Gr FG 260 epoxy coated
5.19	Butterfly Valves: Shaft	BS 970 431 S: 291/EN 57, or AISI-410/SS to ASTM-A-479 type 304
5.20	Butterfly Valves: Body Seat Ring	18-8 Stainless steel/Clamping ring SS to ASTM-A-479 type 304
5.21	Butterfly Valves: Companion flange	CS to IS 2062
5.22	Butterfly Valves: Disc Seal rings	Nitrile Rubber/EPDM
5.23	Butterfly Valves: Seal retaining rings	Stainless Steel
5.24	Sludge pit isolation valves - Body	ASTM A 216 Gr. WCB
5.25	Sludge pit isolation valves -Spindle & Trim	ASTM A 182 Gr. F6 or Equivalent
5.26	Sludge outlet pipe	CI IS-1536, LA
5.27	Stop Log gate in Cold water Outlet Basin	As specified in civil specification
5.28	Guide for Stop Log gates	
5.29	Screen	
5.30	Guide for Screen	
5.31	Bolts, nuts & other hardware	Silicone bronze (wet); stainless steel 316 (dry)
5.32	Submesible Sludge Pumps - Casing	2.5 Ni% Ni-Ci to IS 210 Gr. FG-260
5.33	Submesible Sludge Pumps -Impeller	ASTM A351 CF8M
5.34	Submesible Sludge Pumps - Shaft/Sleeves	SS-316/SS-410
5.35	Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity	Hot dip galvanized mild steel rung ladders with etch primer and bituminous painting
5.36	Material of construction for items not specified	As per purchaser's approval during detailed engineering.

6.0	**INSPECTION/TESTING**	
6.1	Quality Surveillance by	Manufacturer, BHEL and Customer
6.2	Material testing and identification	Required
6.3	Stage inspection to be witnessed by BHEL and Customer	Yes
6.4	Hydrostatic test for piping & valves required	Yes
6.5	Hydrostatic test to be witnessed by BHEL and Customer	Yes
6.6	Field performance test of individual items and the cooling tower as a whole required	Yes
6.7	Field performance test to be done by	Refer PG test clauses in specification. In addition, PG test shall be carried out by the bidder 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 permissible deviation from the design conditions as specified, preferably in the period from May to September.
6.8	All testing instruments by supplier	Yes
6.9	Commissioning at site by	by bidder

SL.NO	DESCRIPTION	UOM	DETAIL
7.0	**DESIGN CODES & STANDARDS**		
7.1	Acceptance Test Code for Industrial Water Cooling tower	-	Cooling Tower Institution of USA, Bulletin ATP-105
7.2	Performance Test Code for Atmospheric Water Cooling equipment	-	PTC-23:ASME
7.3	Acceptance test code for cooling towers	-	CTI ATC 105
7.4	Specification for Water Cooling Towers	-	BS-4485
7.5	Heat exchangers method of measurement and evaluation of thermal performances of wet cooling towers	-	BS EN 14705
7.6	Thermo-Hydraulic Design of Natural Draught Counter Flow Cooling Towers — Guidelines	-	IS 18705
7.7	Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Towers	-	IS: 11504
7.8	Polyvinyl Chloride Materials used for Film Fill, Louvers and Drift Eliminators	-	Cooling Technology Institute of USA, STD-136
7.9	Standard for Water Flow Measurement	-	Cooling Technology Institute of USA, STD-146
7.10	CTI fastener material guidelines	-	Cooling Technology Institute of USA, ESG-144
7.11	Recommended guidelines for Portland Cement Concrete for Mechanical draft Cooling Towers	-	Cooling Technology Institute of USA, ESG-153
7.12	American Water Works Association standard for Steel Pipe Flange for Waterworks service	-	AWWA C207
7.13	American Water Works Association standard for Rubber seated Butterfly valve	-	AWWA C504
7.14	Materials of various components such as PVC, plain and reinforced concrete, bars and steel wires for concrete reinforcement etc. shall be in accordance with relevant Indian Standards or else to applicable American Standards.	-	as per applicable codes
7.15	American Society of Testing Materials	-	as applicable
8.0	**DESIGN /SYSTEM PARAMETERS FOR EACH COOLING TOWER**		
8.1	No. of Cooling Towers required	Nos.	One (01)
8.2	Duty	-	Continuous
8.3	Type	-	Natural draught Cooling tower, Hyperbolic
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	83500
8.7	Design Ambient Wet bulb temp	Deg C	28
8.8	Design Inlet wet bulb temp	Deg C	28
8.9	Design Cold water temperature	Deg C	33
8.10	Hot water inlet temperature	Deg C	44
8.11	Cooling Range	Deg C	11
8.12	Design Ambient Relative Humidity	%	45

8.13	Fill zone KaV/L can be enhanced to account for contribution of rain zone only (KaV/L in Spray Zone is not allowed in the thermal sizing calculation of Cooling Tower)	%	Max. 20 % of $(KaV/L)_{Fill}$ $(KaV/L)_{Tower} = (KaV/L)_{rain} + (KaV/L)_{Fill}$ The design L/G for the tower will be at a point where the combined KaV/L from fill and rain zone meet the demand KaV/L.
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 w.r.t. FGL (Top elevation of hot water distribution header) - Frictional losses within bidder's T.P. with 10% margin	MWC	16.0
8.16	Maximum permissible Evaporation loss.	%	By bidder
8.17	Maximum permissible drift loss	%	0.05% (Max.) of rated capacity of Cooling Tower flow
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 and cold water channel	%	120 % of design flow
8.20	Finished ground level (FGL)	M	EL (-) 0.5 M (RL 270.0 M)
8.21	Maximum water level	M	EL (-) 0.3 M (RL 270.2 M)
8.22	Normal Water Level	M	EL (-) 0.9 M (RL 269.6 M)
8.23	Min. Water level	M	EL (-) 1.4 M (RL 269.1 M)
8.24	Min. Free board above Maximum water level	M	0.3 M
8.25	Effective basin storage Capacity		10 minutes of design cooling tower flow (between Min. & Max. water level)
8.26	Invert level of CT Basin at centre	M	EL (-) 1.9 M (RL 268.6 M)
8.27	Invert level of CW channel near CT Outlet	M	EL (-) 5.5 M (RL 265.0 M)
8.28	Basin type		Sectionalized (two equal compartments) by RCC partition. Each basin chamber shall have overflow arrangement and sludge pit end with necessary provision for dewatering arrangement
8.29	Minimum Basin inside Diameter	M	130
8.30	Maximum Basin inside Diameter	M	135
8.31	Sludge pit (inside basin) size	mm X mm	2000 x 2000 mm for satisfactory cleaning of tower
8.32	Depth of Sludge pit	M	Suitable for complete dewatering of CT basin.
8.33	Number of sludge pits	No.	Two (2) with isolating valves, and spool pipe

8.34	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. The basin outlet shall be sized for water velocity not exceeding 1M/sec at minimum water level. Common water outlet channel shall match with Purchaser's channel at TP (Annexure-II)
8.35	Number of screens and gates in common outlet channel/Basin each) (Minimum)	No.	One (1)
8.36	Length of CW Outlet/Channel from edge of CW Basin in CT vendor's scope		Refer Annexure-II & III
8.37	Depth of CW channel at terminal point		Refer Annexure-II
8.38	Maximum allowable effective velocity through Cold water Outlet Channel	M/sec	1
8.39	Maximum allowable effective velocity through gates/screens at Min. Water Level	M/sec	1
8.40	Maximum allowable velocity in water Pipes	M/sec	2
9.0	**PERFORMANCE PARAMETERS (TO BE GUARANTEED BY BIDDER)**		
9.1	Cold-water temperature	DegC	33
9.2	Maximum CW Pumping head permissible (as per sl. no. 8.15 above)	MWC	16

CHAPTER – 18

NATURAL DRAUGHT COOLING TOWER

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CHAPTER – 18

NATURAL DRAUGHT COOLING TOWER

18.1 CODES & STANDARDS

The design, construction, manufacture, performance, testing and commissioning of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of Practice. The latest editions of the following standards and publications shall be followed in particular:

18.1.1 BS 4485 Water Cooling Tower (Part 1 thru' 4)

18.1.2 Cooling Tower Institute of USA, Bulletin ATC-105: "Acceptance Test Procedure for Water Cooling Tower."

18.1.3 CTC ATC-105: Acceptance Test Code for Water Cooling Towers

18.1.4 IS: 11504: Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Towers.

18.1.5 ANSI/ASME PTC-23: Performance Test Code for Atmospheric Water Cooling Equipment.

18.1.6 Cooling Technology Institute of USA, STD-136: "Polyvinyl Chloride Materials used for Film Fill, Louvers and Drift Eliminators.

18.1.7 Cooling Technology Institute of USA, STD-146: "Standard for Water Flow Measurement".

18.1.8 Cooling Technology Institute of USA, ESG-144: "CTI fastener material guidelines".

18.1.9 Cooling Technology Institute of USA, ESG-153: "Recommended guidelines for Portland Cement Concrete for Mechanical draft Cooling Towers.

18.1.10 AWWA C504: American Water Works Association standard for Rubber seated Butterfly valve.

18.1.10 AWWA C207: American Water Works Association standard for Steel Pipe Flange for Waterworks service.

18.1.11 BS: 3435: Measurement of Electrical Power and energy in acceptance testing.

18.1.12 American Society of Testing Materials.

18.1.13 Materials of various components such as PVC, plain and reinforced concrete, bars and steel wires for concrete reinforcement etc. shall be in accordance with relevant Indian Standards or else to applicable American Standards.

18.1.14 In case of any contradiction between the aforesaid Standards and stipulations as per this technical specification as specified hereinafter, the stipulations of this technical specification shall prevail.

18.1.15. Also, in case of any contradiction between this technical specification and stipulations of the enclosed "Data Specification Sheets", the stipulations of the Data Specification Sheets will prevail.

18.2 **GENERAL REQUIREMENTS**

18.2.1 The cooling tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature and other design parameters as enumerated in the enclosed Natural Draught Cooling Tower Data Specification Sheets.

18.2.2 The cooling tower shall be designed for continuous operation throughout the year, unless specially stated otherwise in Data Specification Sheet. The guaranteed performance (cold water temperature) shall be achieved at all wind velocities as specified.

18.2.3 The cooling tower shall also give satisfactory performance while handling the specified water during monsoon months, with the range as indicated in Data Specification Sheet.

18.2.4 For arriving at the air properties such as enthalpy, density etc., no correction for altitude shall be considered. All properties shall be taken from the data provided on CTI or BS code corresponding to sea level.

18.2.5 Bidder shall also furnish the following in support of tower design and performance, along with the bid without which the offer is liable for rejection.

18.2.6 Heat balance calculations.

18.2.7 Justification for the outlet air temperature. This could be in the form of operating experience on existing tower or laboratory test on actual fill shape, material and configuration as offered. In the case of laboratory test, Bidder shall indicate correction / scaling factor applied to predict performance of full size tower under field conditions.

18.2.8 Calculations to show the adequacy of tower height to provide the required Draught.

18.2.9 Calculations for tower duty coefficient and performance coefficient.

18.2.10 Sketch showing fill arrangement which should clearly indicate the total depth, horizontal and vertical spacing.

18.2.11 Drift loss of the cooling tower expressed in % of rated capacity shall be limited to as close to zero as possible.

18.2.12 The Bidder shall assume full responsibility in proper design and operating of each and every component of the complete cooling tower as well as the cooling tower as a whole.

18.2.13 The cooling tower shall be designed to use filtered water to reject the steam cycle heat load from the steam surface condenser as well as the auxiliary Cooling Water System directly to the atmosphere. Cycle of concentration shall be 5 (minimum) to optimize the use of inlet water. The hot water distribution pipes for counter flow type shall distribute the hot water over the Fills. The hot water cools by evaporation as it drains through the fill into the cooling tower basin.

18.2.14 **Design Criteria**

The layout of the cooling tower in the plant area and the wind rose are indicated in the plot plan drawing. The Bidder shall examine the proposed layout of the tower and accordingly determine the recirculation which must be taken into consideration for the purpose of design of the tower to ensure that the design parameters of the tower are maintained. Bidder may consider to apply a correction factor to the design wet bulb ambient temperature to accommodate the recirculation effect.

Sensible heat of evaporated water shall be taken into consideration in the thermal design of the cooling tower. The air flow requirement shall not be less than that worked out by the formula given below.

$G \times H = L (T1 - T2) + EvT2$

Where

L = Water flow rate in Kg/Hr

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

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

Ev = Evaporation loss in Kg/hr. To compute this factor, RH shall be taken as specified.

G = Air rate in Kg/hr.

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

Calculations justifying the selected air flow and evaporation loss shall be enclosed with the bid. International / National standard table of properties of air shall be used; and a copy of the table clearly indicating the standard used shall be enclosed with the bid.

The bidder shall furnish in his bid the following:

a) Heat balance calculations and air requirements for cooling tower, Calculations justifying the selected air flow and evaporation loss.

b) Available tower characteristics (KaV/L – as a function of air & water rates, fill geometry, hot water temperature, air velocity etc.) based on field performance tests. The relationship shall be of general as per the equation below and shall include values of the constants "c" and "n". The equation shall cover range of "L/G" values from atleast 20% above to atleast 20% below design.

$KaV/L = c(L/G)^n$

The bidder shall also submit an equation and/or curve defining the demand requirement at design approach, range and wet bulb temperature. The design "L/G" value shall be identified.

c) Calculations for pumping head

d) Tower Performance curves

The Bidder should establish and prove the validity and the basis of procedures and methods used in the calculations.

18.3 **SCOPE**

The following Equipment shall be supplied under this specification.

18.3.1 **General**

- Design, manufacture, supply and delivery of plant and equipment to site, storage at site, material handling, construction/ erection including all civil & structural works and bar bending schedules, aviation lighting, lightning protection, earthing, illumination and provision for instrumentation works, final checkup, connected channel works and piping works within the battery limits, performance testing, painting and commissioning of one (1) Natural Draught RCC Cooling Tower.
- Thermal, mechanical and structural design of cooling tower including all appurtenant civil works.
- Supply at site of all materials and equipment required for construction.
- Construction of cold water basin, cold water outlet channel/ duct and basin de-sludge arrangement, including stop loggates and screens and gantry structure for lifting tackles.
- Hot water distribution piping/ducting along with spray nozzle system.
- Supply, shop testing of components and erection of all mechanical equipment, fill, Spray nozzles, etc.
- Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure/super structure in a water free condition is in the scope of work of the Bidder. Dewatering shall be planned and continued till backfilling is completed. For discharge of sub-soil water a suitable pipeline system with pumping arrangement shall be provided to the nearest drain with the prior approval of the Owner.
- Fills and their support members, precast concreting work etc.
- Water distribution system of approved design along with its support members.
- Staircases with handrails and posts, platforms, FRP access doors with all accessories, internal walkways and walkways at CT top with stainless steel pipe handrails and posts, all necessary stainless steel inserts in the concrete etc., for satisfactory maintenance of the Cooling Tower as detailed in civil tender specification.
- Water proof painting of all internal surface of the basin, shell and fill supports, structures, water distribution ducts and external surfaces of the basin and foundations.
- The drift eliminators shall limit the drift loss to 0.05% of total water in circulation. The air pressure drop across the drift eliminators shall be kept to a minimum by suitable design. The water collected in the drift eliminators shall be returned to the Tower basin and it shall not mix with the discharge air system. The bidder shall demonstrate the efficiency of the drift eliminators by means of tests as per BS 4485 Part 2.

- The drift eliminators shall be made of virgin PVC. It shall be highly resistant to deterioration and fire retardant. The make and properties of the fill shall be subject to the approval of theOwner Owner.

- Complete electrical grounding, illumination, lightning protection system and aviation warning system with necessary stainless steel inserts conduits and cabling, necessary power distribution arrangement as per technical specification for "Volume IV: Electrical Works,".

18.3.2 **Mechanical works**

a) Hot water distribution spray system of reliable & efficient design, along with its supporting arrangement.

b) Hot water duct/pipe work along with supports and anchors.

c) Motor operated with chain pulley arrangement isolation valves on hot water inlet piping before hot water distribution system to achieve basin maintenance.

d) Painting both inside and outside surfaces of steel pipes with three coats of rust and corrosion resisting paint including thorough cleaning of the surfaces.

e) Tower fill, drift eliminators including all required supporting structure and accessories, etc. as necessary.

f) Screens along with guides embedded in concrete at each of the cold water outlet channels from the cold water basin.

g) Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.

h) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates.

i) Cold water outlet duct/tunnel.

j) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels.

k) Tower Fill Hot water By-Pass Nozzle connections on Hot water duct/ piping for system lines flushing during commissioning.

l) Instrument tapping provisions on hot water duct/piping and cold water duct/piping for carrying out flow and temperature measurement during PG test.

18.3.3 **Electrical Works**

Refer Volume IV.

18.3.4 **Civil Works**

Refer Volume-VI.

18.3.5 Any additional equipment, material, services which are not specifically mentioned here, but are required to make the plant/systems in the scope of the Bidder complete in every respect in accordance with the technical specification

and for safe operation and guaranteed performance, shall be deemed to be covered under the scope of this specification.

18.3.6 All accessories and hardwares.

18.3.7 The scope of this specification also includes erection, installation, site testing, commissioning, trial run, performance and guarantee tests, training of operating personnel, O&M of the plant till commencement of commercial operation and other erection services to ensure trouble free operation and commissioning of the Equipment/System.

18.4 DESIGN AND CONSTRUCTION

18.4.1 The Structure

a) The Cooling Tower shell shall be hyperboloid.

b) The shell of the Cooling Tower shall be supported by a set of diagonal columns, which shall be supported by raker piles and a peripheral pile cap and on an annular raft depending on final soil investigation report to be conducted by the bidder.

c) Hot water inlet shall be through a pair of steel pipes.

d) To control the hydraulic forces at the change of alignment of the hot water (HW) inlet pipe, at ground level near the Cooling Tower, RCC thrust block shall be provided.

e) The hot water distribution shall be by RCC main and secondary ducts finally through UPVC/HDPE/FRP pipes fitted with nozzles for uniform distribution through the fill, which shall be ~~film type.~~ shall be as per cl. no. 18.4.3.1 (as per corrigendum 5)

f) When selecting the spray equipment and its position, it shall be ensured that maximum heat transfer is achieved above the parts installed with the system chosen. Optimum cascading is to be attained using spray equipment with staggered nozzle sizes.

g) The concrete main distribution ducts shall be accessible and are to be provided with non-corroding, pressure-sealed inspection openings. Cleaning and sludge-removal openings shall be included on each run at the end of the duct in the main distributor pipes.

h) The profile of the drift eliminators shall be selected to ensure a maximum degree of precipitation and minimum air pressure loss.

i) The HW distribution arrangement shall be supported independent of the shell by internal columns finally supported on the floor of the cold water basin.

j) Access to the hot water distribution system shall be provided with two RCC stair leading to FRP door giving access to distribution system.

k) The material used for access facilities including steel components for steps, ladders, platforms, catwalks, railings, doors, base frames, mountings, etc shall be resistant to corrosion.

l) All bolted connections and attachments to concrete shall be made out of suitable stainless steel.

m) The Cooling Tower basin shall be divided into two equal parts by watertight RCC partition for cleaning and HW distribution and maintenance of one half while the other half is in service. Arrangements for the HW distribution and water drainage shall also be provided with suitable valve chamber and submersible drain pumps for each Cooling Tower.

n) The basin and cold water discharge channel shall be capable of handling 120% of design flow or the both CW pump run-out flow whichever more, without any over flow. The basin outlet shall be sized for water velocity not exceeding 1M/sec at minimum water level. The cold water from the basin shall be conducted through an opening in the cold water basin and led to the fore-bay of the CW sump. The cold water from the basin shall flow by gravity to open approach channel leading to the fore-bay. The cold water channel shall be provided with stop log gates & screens. Suitable handling arrangements with monorail and chain-operated hoists with travelling trolley shall be provided for handling of the stop log gates & screens. In front of the outlet structure, provision shall be made for de-sludging facilities, so that sediments can be withdrawn near the basin. In order to clean the Cooling Tower basin, sludge sumps for each half of basin compartment shall be provided from where the sludge can be pumped out.

o) The water collection basin, consisting of base slab and basin wall, shall also serve as a water reservoir. The basin wall shall be inside the diagonals.

p) Structural Design Concepts shall be as described in Volume VI: Civil Specification.

q) To handle stop log gates & coarse screens, mono rails shall be provided across each cold water channel. Separate Hand operated chain pulley blocks with travelling trolley of adequate capacity to handle stop log gates and coarse screens shall be provided for each Tower. The capacity of the hoist however shall in no case be less than 125 % the weight of the stop log gate / screen. Coarse screen dimensions shall be identical and interchangeable.

18.4.2 **Hot Water Distribution System**

18.4.2.1 The distribution system shall be designed for flexible and satisfactory operation at all reasonable loads.

18.4.2.2 The hot water distribution shall be suitable for handling an additional 20% flow over the design circulating water flow. The hot water distribution shall be done by two headers, each covering half of cooling tower area so that it can be operated at 50% capacity.

18.4.2.3 The hot water distribution piping and valves shall be designed for a working pressure as calculated by the Bidder.

18.4.2.4 The spray system can be either upward or downward maintaining water spray even with shutdown flows.

18.4.2.5 The nozzles shall be arranged in a uniform pattern with proper distance to produce 15% overlapping of the individual sprays. This arrangement shall provide extremely even water distribution with uniformly sized droplets entering

the fill. The spray overlapping required avoiding dry pockets in the fill due to variations expected in water head availability in main hot water duct.

18.4.2.6 The spray nozzle shall be reliable and effective in breaking the hot water jet into a spray pattern of uniformly sized droplets. It should be proven and tested design to provide maintenance free service for minimum 3 years.

18.4.2.7 The fixing arrangement of spray nozzles to hot water distribution header shall be of flanged joint type. Screwed joint shall be avoided as they are likely to get loosened due to flow induced vibrations.

18.4.2.8 The distribution of water shall be in Ducts / troughs of approved material. The entire water distribution system shall be self-draining and non-clogging type.

18.4.2.9 The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs / pipes.

18.4.2.10 The structural design of the water distribution system shall also consider the following loadings, combined as appropriate.

- Self weight.
- Hydraulic pressure during normal operations, including pressure surges.
- Hydraulic pressures due to mal-operation of tower or supply pumps.

18.4.2.11 Seismic loading on the water distribution system shall also be considered.

18.4.2.12 The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loadings in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design. The pressure level to be considered shall not be less than 1.5 times the design pressure.

18.4.2.13 The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature, outlet water temperature and ambient temperature.

18.4.2.14 If open basin system of distribution is provided, the basin shall be provided with removable type covers made of pre-cast concrete.

18.4.2.15 Splash boxes in cross flow tower shall be provided at the discharge of each distribution valve to minimize splashing and to facilitate even distribution of water.

18.4.2.16 The nozzles shall be spaced to give even distribution of water over the entire space occupied by top row of fills.

18.4.2.17 The nozzles and splash bars shall be made of High Density Polyethylene UV rays stabilized.

18.4.2.18 The pipes & valves etc. used shall be designed and arranged to take care of the possible thermal stress due to temperature variation. The pipes & fittings shall have extra heavy thickness.

18.4.2.19 Ready accessibility to the different parts like isolation valves etc. shall be provided and as required necessary platform/walkway and ladder shall be provided for this purpose.

18.4.3 **Fill & Fill Supporting Arrangement**

18.4.3.1 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.

18.4.3.2 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.

18.4.3.3 The fill material shall be highly resistant to deterioration and shall be fire retardant. PVC/PP fill shall be of proven quality. The Properties of PVC/PP material for the fills shall be in line with CTI-136 2010.

18.4.3.4 The type of fill to be supplied for this package shall be of proven design. The performance of the fill should have been established for the specified/higher duty conditions.

18.4.3.5 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 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.

18.4.3.6 The supporting of the fill shall be achieved by a series of precast RCC columns arranged in suitable grid spacing and precast beams in orthogonal directions. Loads from fills, hot water ducts, pipes including water load, wall blocks etc shall be considered for column design. To take care of horizontal loads due to seismic and thrust from hot water header, a suitable system of vertical bracings is to be designed and provided in either direction.

18.4.3.7 Concrete impermeable to water shall be used for all components, including reinforced concrete components. The composition of the concrete and the cement shall be chosen depending on the chemical analysis of the Cooling Tower water/Cooling Tower make-up water.

18.4.4 **Drift Eliminators**

18.4.4.1 Zig-Zag path type Multi pass Drift eliminators (minimum two pass) shall be provided so as to limit the drift loss to that specified earlier or as in the Data Specification Sheet.

18.4.4.2 In case the tower is provided with pre-stressed concrete or PVC fill, drift eliminators may be made up of PVC.

18.4.4.3 The eliminator frame shall be of rugged construction and shall be firmly secured to arrest vibration.

18.4.5 **Access**

18.4.5.1 Staircases shall be provided external to the cooling tower along with stairways, landings, walkways, handrails and access doors. Minimum 2 Nos. staircase 1000 mm wide and minimum landing width of 1000 mm at locations as necessary to give safe and convenient access to the top and the interior parts of the tower.

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

18.4.5.3 Whether specifically mentioned in the Data Sheet or not, steel components and fittings used in walkways, ~~handrails~~ shall be hot dip galvanized after fabrication followed by one coat of etching primer and two coats of bituminous paint.

18.4.6 **Cooling Tower Basin & Outlet Sumps**

18.4.6.1 The hot water distribution system, basin and cold water outlet channel of the cooling tower shall be designed by considering a minimum of 20% margin over the design cooling tower flow.

18.4.6.2 Cooling tower basin, shall be supplied/constructed along with all civil parts, base plates, anchor bolts, nuts, and other accessories, pipe sleeves, inserts, etc. and as required to complete the work in all respects.

18.4.6.3 The work shall include excavation/back-filling as necessary, all concrete/steel work, cold water outlet sump & sludge pit for each basin, water-proofing and all other works.

18.4.6.4 The basin shall be partitioned into two individual chambers such that one section can be taken out for maintenance /de-sludging while the other section is in operation.

18.4.6.5 Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.

18.4.6.6 For each basin chamber, there shall be a cold water outlet sump. In the connection between basin chamber and cold water sump there shall be screen and sluice gate/Butterfly valve.

18.4.6.7 Each basin chamber shall have overflow arrangement at sludge pit end.

18.4.6.8 Basin slope towards cooling sump shall be 1 in 120.

18.4.7 **Stoplog Gates & Handling Facility**

a) Stop Log Gates shall be providsed for isolation of Cooling Tower from CW Channels. These gates shall be provided with guides and sealing arrangement. Hooks shall be provided for lifting the gates.

b) Designing, supplying, fabricating and installing in position leak tight log gates in CW channels for the maximum water head including forming grooves with stainless steel channels, providing lifting hook arrangement etc. Detailed design and drawings are to be submitted by the Bidder during detailed engineering.

c) Stop logs shall be complete with guide shoes, bearing blocks, rubber seals, lifting lugs etc. The stop log gate shall cover the clear opening of the cold water channel and effectively stop the water leakage. The minimum thickness of skin plate shall be 6 mm. The structural design of the stop log gate shall generally conform to IS: 5620-1986.

d) To handle the stop log gates, monorails at sufficient height shall be provided across each cold water channel. Hand operated chain pulley blocks with traveling trolley of adequate capacity to handle the stop log gates shall be provided for each Tower. The capacity of the hoist however shall in no case be less than 125% the weight of the stop log gate.

18.4.8 **Screens**

Design, Supplying, fabricating and installing in position wire mesh screen of stainless steel (SS316) wire mesh 12 SWG and 10 mm clear sieve opening with frame and stiffeners with MS confirming to IS 2062 (epoxy painted), guide & concrete embedment with stainless steel, fixing in position in Cooling Tower outlet with inserts/lugs, providing lifting hook arrangement etc. All bolts, nuts and washers if used shall be of stainless steel conforming to grade SS 316. Detailed design and drawings shall be furnished by the Bidder. The structural design of the coarse screen shall generally confirm to IS: 11388

i) Quantity - 2 Nos. (1 No. per partition) - (as per corrigendum 5)

ii) Purpose - For filtering suspended matter, if any, in circulating water.

iii) Size of mesh - 10 X10 mm

The size of the screen shall be such that it can be handled easily.

18.4.9 **Hardware**

All nails and fastening bolts, nuts & washers used in the cooling tower stainless steel, if not specified in the Data Specification Sheet.

18.4.10 **Aviation Warning Lights**

All the aviation warning lights shall be approachable. In accordance with official regulations, aviation warning lights shall be installed along the perimeter of the Cooling Tower opening as per ICAO requirement. They shall be connected to completely separate power circuits and to be monitored by relays.

The technical requirements of aviation warning lighting, lightning protection system, earthing, lighting, and cabling etc. shall be as described in Electrical volume.

18.5 **TESTING AND INSPECTION**

18.5.1 **General**

18.5.1.1 Inspection and testing of bought-out equipment shall be carried out by the Owner as per the mutually agreed QAP at the works of Bidder or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of Technical Specifications, approved drawings, authenticated manufacturing drawings and reference National/ International standards.

18.5.1.2 The Bidder shall furnish Quality Assurance Plan (QAP) for respective equipments for Owner's approval at least two months prior to start of manufacturing.

18.5.2 **Testing and Inspection at Manufacturer's Works**

18.5.2.1 The Bidder shall conduct all tests required on various bought-out components including those specifically mentioned in the respective equipment specification sections to ensure that the system/equipment furnished shall conform to the requirements of the specification and in compliance with the requirements of applicable codes and standards.

18.5.2.2 Particulars of the proposed tests and procedures for the tests shall be submitted to the Owner in the draft QAP for approval before conducting the tests.

18.5.2.3 Stop Logs Gates and screens welding shall be done by qualified welders and Dye Penetration Test (DPT) on welds shall be carried out.

18.5.2.4 Stop logs shall be checked for confirming to relevant IS dimensional conformity in shop and smooth operation and leakage tightness at site.

18.5.2.5 Galvanized items shall be checked for thickness of coating, weight of zinc coating, adhesion test, visual examination and pierce test (uniformity of coating) as per the requirement of relevant IS codes and as directed, by the Owner.

18.5.2.6 Valves

a) Hydrostatic pressure test of the body and seat as per relevant standard for all the valves.
b) Disc strength test and life cycle test shall be conducted additionally for the butter fly valves as per the applicable standard.

18.5.2.8 Stop Log Gates (at site)

a) Total assembly alignment
b) Dimensional check
c) Seat leak test and other tests as per relevant IS

18.5.2.9 Coarse Screen

a) Total assembly alignment
b) Dimensional check and other tests as per relevant IS

18.5.2.10 Submersible pump:

a) Flow
b) Pressure
c) Auxiliary Power consumption (Power input to motor)

18.5.2.11 Chain pulley block: Tests shall be conducted as per IS: 3938.

18.5.2.12 Fills and Drift Eliminators:
The following tests shall be conducted

a) Tensile strength & elongation : ASTM D638 & ASTM D882
b) Flammability : ASTM D635
c) Tensile modulus : DIN 53457
d) Impact strength : ASTM D256

18.5.3 **Performance Guarantee Tests at Site**

18.5.3.1 Performance testing of Cooling Tower shall be carried out as per ATC-105 at a time when the atmospheric conditions are within the permissible limits of deviation from the design conditions. Correction curves shall be applied for correction of the test results for deviation of test conditions such as flow rate, cooling range and wet bulb temperature and dry bulb temperature/ relative humidity.

18.5.3.2 After construction of the Cooling Tower, the complete systems/ equipment shall be operated at site to show satisfactory performance as required by the applicable Clauses of the specification. Further all piping shall be hydraulic tested at site.

18.5.3.3 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to final trial run and commissioning of the complete system/ equipment.

18.5.3.4 To ascertain the fulfillment of guarantees, performance tests shall be carried out on all the Cooling Tower erected under this contract at site. The procedure to be followed and other conditions shall be as given below.

a) Acceptance test procedure shall cover the determination of the thermal capability and verification of all guaranteed parameters of the Cooling Tower(s) supplied for the Project.

b) The purpose of this test procedure is to describe instrumentation and procedures for the testing and performance evaluation of water Cooling Tower.

c) Latest versions of the codes and standards as per clause # 18.1, shall be applicable for conducting test unless otherwise modified to be supplemented by the following procedure and mutually agreed to, between the Owner and the Bidder:

d) Conditions of tests

i. Accredited representatives of the Bidder and the Owner along with Consultants shall conduct tests for the tower. The Bidder shall be given permission to inspect the Tower in advance and make it ready for the test. Bidder's representatives shall witness all phases of the test and record the data jointly with the Owner's representatives in the agreed formats.

ii. The responsibility for conducting the test lies with the Bidder.

iii. All test instruments required for the Performance Guarantee Test (PG Test) shall be provided by the Bidder. Calibration of test instruments shall be the responsibility of the Bidder. After PG test, special test instruments, if any, brought for the test can be taken back by the Bidder on getting clearance from the Owner.

iv. Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments shall be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments shall be valid for the period of test.

v. List of instruments to be arranged by the Bidder along with the calibration certificates of the instruments to be used, psychometric charts and tables shall be submitted to the Owner/ Consultant for approval in advance.

vi. Performance guarantee tests shall be carried out by the Bidder 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 permissible deviation from the design conditions as specified in this section preferably in the period from May to September.

vii. Performance Test shall be carried out based on ambient W.B.T. The performance curves of the Cooling Tower showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity, water loading of the Tower, approach, terminal temperature difference etc., required to ascertain the performance of the Tower shall be furnished along with the Tender. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished. Each set shall consist of three or more cooling range curves and at least four relative humidity curves, arranged to show the effects of wet bulb temperature, relative humidity and cooling range on outlet water temperature. The range curves shall be presented in uniform increments of 0.5^{o}C, with sufficient scope to cover approximately ± 20% of design range. The relative humidity curves shall be presented for spaced increments to cover the extent of expected conditions such as 5, 20, 40, 60 and 80% relative humidity. The design conditions shall be indicated on the set applicable to design water flow rate.

viii. The dry bulb temperature associated with the wet bulb on each fixed relative humidity graph shall be included (if applicable). All performance curves shall be based on ambient wet bulb temperature.

ix. The Bidder shall demonstrate the guaranteed performance of the Cooling Tower after evaluating the PG. Test. Should the result of the test deviate from the guaranteed values, the Bidder shall be given an opportunity to modify the fill etc. required to enable it to meet the guarantees. In such cases the P.G. Test shall be repeated within one month from the date on which the Cooling Tower is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The opportunity for repeat testing shall be given only once during the contract period.

x. In case the test cold water temperature as determined from the PG Test is higher than the predicted value (based on the performance curves), the Owner reserves the right to accept the tower after assessing the liquidated damages as per Volume II A for rise in cold water temperature.

xi. A maximum tolerance of 0.3° C in the cold water temperature of the guaranteed value shall however be allowed to take care of instrument inaccuracies. No other tolerances shall be permitted.

18.5.4 **General conditions of Cooling Tower**

a) Condition of Cooling Tower

i. At the time of the test the Tower shall be in good operating condition. Tower may be inspected and repaired, (if necessary) by the Bidder, before the test to ensure the following:

ii. Water distribution system shall be essentially clear and free of foreign materials which may impede the normal water flow. Fill shall be essentially free of foreign materials such as oil, tar, scale or algae. Water level in cold water basin shall be at normal operating elevation and shall be maintained substantially constant during the test.

b) Operating Conditions

i. Every effort shall be made to conduct the test under design conditions, or as close to design conditions as possible. The test shall be conducted within the following limitations.

ii. The following variations from design conditions shall not be exceeded:

a) Wet bulb temperature	:	± 5%
b) Dry bulb temperature	:	± 10%
c) Range	:	± 20%
d) Circulating water flow	:	± 10%
e) Heat load	:	± 20%

c) Duration of test

i. After reaching steady state conditions, the duration of the test run shall not be less than mentioned in the standards. If thermal lag

time is greater than five minutes, the time for the tests period shall be at least one hour plus thermal lag time.

ii. Readings shall be taken at regular intervals and recorded in the units and to the number of significant figures as shown in the following tabulation.

	Measurement	Minimum number each per station	Unit	Record to nearest
	Wet bulb temperature	12	Deg C	0.05
	Dry bulb temperature	12	Deg C	0.05
	Cold water temperature	12	Deg C	0.05
	Hot water temperature	12	Deg C	0.05
	Wind Velocity	6	Kmph	
	Circulating Water Flow	**		
**	Single centre point readings for comparison with full traverse reading taken before test (when measurement is made by Pitot Tube). One full traverse shall be made immediately preceding the test and a minimum of three centre point readings shall be taken during the test.			

d) Consistency of test condition

For a valid test, variations in the test condition shall be within the following limits:-

i. Circulating water flow shall not vary by more than 5%.

ii. Heat load shall not vary by more than 5%.

iii. Range shall not vary by more than 5%.

iv. Instantaneous air temperature readings may fluctuate, but variations in the averages during the test period shall not exceed the following.

1. Wet bulb temp - 1^0 C/hr.
2. Dry bulb temp. (if applicable) - 3^0 C/hr.

18.5.5 **Test Instruments, their location and method of measurements**

All instrumentation used for Performance Testing shall conform to Clause 3, page 5 of CTI cod ATC 105/ February 2000.

a) Wet Bulb Temperature.

i. The wet bulb temperature shall be measured with mechanically aspirated instruments, each meeting the following requirements:

ii. The indicator shall be graduated in increments of not more than 0.1oC. The temperature sensitive element shall be accurate to + 0.05oC. The temperature sensitive element shall be shielded from

direct sunlight or from other significant sources of radiant heat. Shielding devices shall be substantially at the dry bulb temperature. The temperature sensitive element shall be covered with a wick that is continuously fed by distilled water.

iii. The temperature of the distilled water used to wet the wick shall be at approximately the wet bulb temp. being measured. This may be obtained in practice by allowing adequate ventilated wick between the water supply and the temperature sensitive element. The wick shall fit snugly over the temperature sensitive element and extend at least two centimetres past the element over the stem. It shall be kept clean while in use.

iv. The air velocity over the temperature sensitive element shall be maintained between 290 and 320 M/minute.

Number of stations and their location.

i. Ambient wet bulb temperature.

ii. The ambient wet bulb temperature shall be determined as the arithmetical average of measurements taken at not less than three locations approximately 1.5 M above basin curb elevation, not less than 15 metres or more than 100 M to windward of the equipment, and equally spread along a line substantially bracketing the flow of air to the Tower.

iii. The minimum number of stations for each air intake side may be determined from the following equation:

$n = 0.517 (A)$

iv. Where n is the minimum no. of stations for each side of air intake and A is the area to be traversed in sq. metre. (The area to be traversed applies to each individual air inlet area on each side of the Cooling Tower, rather than the total area applicable for the Cooling Tower).

v. Each intake should be divided into a number of imaginary rectangles and one wet bulb measurement station shall be located in the mid point of each rectangle.

The average of 3 successive readings taken at 10 second intervals at each station shall be considered for wet bulb temperature at that time at that instrument station. The station averages shall be averaged to obtain the effective wet bulb temperature for that run. Such runs shall be made every 5 minutes during the test period and the arithmetic average of these runs shall be considered the ambient wet bulb temperature and shall be used for the evaluation of results.

b) Dry Bulb Temperature

i. The ambient dry bulb temperature shall be measured with instruments each meeting the following requirements:

- The indicator shall be graduated in increments of not more than 0.1^0 C.
- The temperature sensitive element shall be accurate to +/- 0.05^0 C.

- The temperature sensitive element shall be shielded from direct sunlight or from other significant sources of radiant heat. Shielding devices shall be substantially at the dry bulb temperature.

c) Cold Water Temperature.

i. The indicator of the thermometer used for measurement shall be graduated in increments of not more than 0.1^0 C.

ii. The re cooled water temperature can be measured directly at the point where the circulating water is discharged from the basin, the average cold water temperature being determined by simultaneous recording of test reading where possible across the selected sections.

d) Hot Water Temperature.

i. The indicator of the thermometer used for measurement shall be graduated in increments of not more than 0.1^0 C.

ii. Hot water temperature measurement shall be made in the Tower risers or at the discharge of inlet risers into the flume or distribution system.

e) Circulating Water Flow

i. Wherever adequate upstream and downstream straight lengths are available, suitable pitot probes shall be used for the flow measurement. Pitot probes shall conform either to ASME (19.5) Chapter 4 (latest revision) or ISO 3966-1977. The probes shall be provided with calibration carried out in a laboratory approved by the Owner. Pitot Tube not conforming to the above codes but fabricated by Indian Institute of Technology Mumbai/Delhi/Chennai or Indian Institute of Science, Bangalore with recent calibration certificate could be used after obtaining prior approval of the Owner.

ii. In case adequate upstream and downstream straight lengths are not available, the probe should conform to ISO-3966-1977. In addition to the probe for velocity measurement, a Yaw- probe shall be required as per ISO-7194-1983 for the measurement of swirl angle. Alternatively, special probe developed by IIT/IISc for simultaneous measurement of velocity and swirl angle can be used.

iii. For obtaining swirl free and fully developed flow condition the minimum upstream and downstream straight lengths at the measuring cross section shall be 20 pipe diameters and 5 pipe diameters respectively. To meet the above criteria, it shall be necessary to provide the stubs along with the isolating valves in the underground portion of the circulating water pipe/ducts leading hot water to the Tower. Provision shall be made for traversing two diameters at right angles to each other.

iv. In case it is not possible to comply with the straight length requirement, the stubs shall be located in hot water pipes where maximum straight length is available. The flow shall be asymmetric

and traversing of 3 or 4 diametres shall be necessary depending upon the available straight length and the type of disturbance.

v. For the measurement of differential pressure, inclined manometer with low density liquid shall be used to minimize the reading error. In case special probe developed by IIT/IISc is used, another manometer with low density liquid shall be required for orienting the probe in the flow direction.

f) Wind Velocity

i. Wind Velocity shall be measured by a rotating cup type anemometer.

ii. Measurement shall be made in an open and unobstructed location within 30 M of and to windward of the Tower at a point 1.5 M above the basin curb elevation.

iii. For the measurement of ambient wet bulb temperature, direction of the wind shall be determined by the anemometer, to fix the location of measurement stations.

g) Computation of Water Flow

i. The water flow for each radii traversed shall be determined separately by graphical integration method. The curves shall be plotted between (radius) versus (radius x velocity) on milli metre graph-sheets on large scale (not less than 1:5) to minimize computational error. The water flow is computed from the following equation :

Water flow (M3/sec) = 2 X π X Area under the curve.

ii. The average flow of all radii traversed is the actual flow through the pipe.

iii. The computed area by graphical integration shall be cross checked with calculated area by numerical integration method. The area obtained by the two methods, may differ depending upon the smoothening carried out while drawing the curves.

18.6 CALCULATION OF TOWER PERFORMANCE

18.6.1 Determination of predicted Cold Water temperature

18.6.2 The cold water temperature shall be read from the performance curves for 90%, 100% and 110% of rated flows at test wet bulb temperature, range and relative humidity. The three points thus obtained from performance curves shall be plotted to obtain a cross plot, which is a relation between water flow and cold water temperature.

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

18.7 ACCEPTANCE CRITERIA

If the cold water temperature is less than or equal to predicted cold water temperature as described above, the Tower is deemed to have met the

guarantee. If the predicted cold water temperature is higer than the guaranteed value, the Tower shall be accepted with LD as per stipulations in Volume 1 of the bid up to an increase of 1^0 C from the guaranteed cold water temperature. If the increase in the predicted cold water temperature is more than 1^0 C from the guaranteed cold water temperature, then the Tower is liable for rejection by the Owner.

18.8 **GUARANTEES**

18.8.1 The Bidder shall guarantee that the Cooling Tower constructed shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

18.8.2 The cold water temperature as specified in technical data sheets shall be guaranteed by the Bidder for the design conditions of CW flow, range, ambient WBT specified in technical data sheets submitted by the Bidder.

18.8.3 (Performance testing of Cooling Tower shall be carried out as per ATC-105 at a time when the atmospheric conditions are within the permissible limits of deviation from the design conditions. Correction curves shall be applied for correction of the test results for deviation of test conditions such as flow rate, cooling range and wet bulb temperature and dry bulb temperature/ relative humidity from their respective design). The correction curves shall be furnished by the bidder after award of contract.

18.9 **PERFORMANCE GUARANTEES**

18.9.1 Each equipment shall be guaranteed to meet the performance requirements as specified. If during the performance testing of the tower, the actual cooling water temperature obtained is higher than the guaranteed cooling water temperature (obtained from the performance curve) corresponding to the flow, wet bulb temperature, relative humidity and cooling range prevailing during the test, the contractor shall satisfactorily rectify all defects within scheduled time period.

18.9.2 After the tests conducted at the Manufacturer's works in accordance with this specification, rectification of any defect observed shall be satisfactorily done without charging any extra cost to the Owner.

18.9.3 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within scheduled time period. No extra cost shall be charged to the Owner for such rectification. After rectification, retesting will be done by Bidder without any extra cost to Owner till satisfactory performance is achieved.

18.9.4 The bidder shall guarantee that the cooling tower offered shall meet the ratings and performance requirements stipulated in this specification. The bidder shall also furnish a declaration for certain guaranteed parameters like "Fulfillment of cold water temperature" which shall attract levees of liquidated damages for shortfall in performance. In case the contractor does not fulfill the guaranteed parameters, Owner may undertake to rectify the system/equipment and expenditure incurred along with any other incidentals shall be recovered from the contractor.

DATA SHEET

S. No.	DESCRIPTION		PARAMETER
1.	**General Information**		
1.1.	Type of Cooling Tower	:	Natural Draft, Hyperbolic
1.2.	No. of Cooling Towers Required	:	One (1)
1.3.	Location	:	Outdoor
1.4.	Duty	:	Continuous
2.	**DESIGN PARAMETERS**		
2.1.	Quantity of Water to be cooled	:	By Bidder
2.2.	Duty of each tower	:	To cool plant circulating water and auxiliary Cooling Water
2.3.	Hot water temperature (°C)	:	Bidder to indicate
2.4.	Cold water temperature (°C)	:	33 (guaranteed)
2.5.	Cooling range (°C)	:	Temperature rise across condenser plus 1 deg. C, keeping hot water temperature at outlet of condenser as base.
2.6.	Design ambient wet bulb temp. (°C)	:	28(refer Project Info, Vol II)
2.7.	Approach (°C)	:	5
2.8.	Design Relative Humidity (%)	:	45 %
2.9.	Design Wind Speed	:	As specified in Project information or Civil Specification, whichever is more stringent
2.10.	Quality of makeup water	:	Filtered Water
2.11.	Max. drift losses	:	0.05% (Max.) of rated capacity of Cooling Tower flow
2.12.	Height of basin curb above Terrace level	:	300 mm
	The Cooling Tower shall be designed for continuous operation to meet the parameters mentioned in broad technical parameters in this Section. The hot water distribution system shall be designed to ensure equal distribution of heat load and flow all over the fill area. Wood/timber shall not be used as material of construction in any part of the Cooling Tower.		
3.	**BASIN (to be designed on uncrack basis)**		
3.1.	Type	:	Single
3.2.	Material of construction	:	Refer Chapter 13 Volume VI
3.3.	Effective storage Capacity	:	10 minutes of cooling tower flow at full load operation of the unit (between Min. & Max. water level)

S. No.	DESCRIPTION		PARAMETER
3.4.	Drain box size	:	2000 x 2000 mm for satisfactory cleaning of tower
3.5.	Number of drain boxes	:	Two (2), per tower
3.6.	Cold water discharge channel / pipe	:	Required effective cross-sectional area for 1.0 metres/sec. water velocity
3.7.	Material of construction	:	Refer Chapter 13 Volume VI
3.8.	Stop log gate on cold water channel	:	As required
3.9.	Cleanable screen	:	As required (10mmx10mmx8 SWG) galvanised steel wire mesh in steel channel frame epoxy painted
4.	**MATERIALS OF CONSTRUCTION**		
4.1.	Structure and basin	:	Refer Chapter 13 Volume VI
4.2.	Fill	:	PVC, Poly Propolene UV rays stabilized, with flute not less than 19mm
4.3.	Fill support	:	RCC
4.4.	Drift eliminators	:	PVC, Poly Propolene UV rays stabilised
4.5.	Drift eliminator support from bottom	:	RCC
4.6.	Nozzles (low pressure non clogging)	:	PVC, Poly Propolene UV rays stabilized / Gun metal as per IS 318 Gr VI
4.7.	Distribution pipes	:	PVC (IS 4985 Class 3)/FRP/HDPE (IS 4984 PN6, grade PE 80)/or RCC/ pre-cast open trough
4.8.	Distribution Trough	:	RCC
4.9.	Hot Water Piping	:	IS 3589
4.10.	Hardware	:	Silicone bronze (wet); stainless steel 316 (dry)
5.	**Stop Log gates**		
5.1.	Guides/ Anchors	:	CS IS 2062 Gr B
5.2.	Gate leaf & lifting beam	:	CS IS 2062 Gr B
5.3.	Rubber seals	:	As per Appendix-B of IS: 4622
5.4.	Lifting Beam	:	CS IS 2062 Gr B

CHAPTER – 27

LOW PRESSURE PIPING, VALVES & SPECIALITIES

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27.0 LP PIPING, VALVES & SPECIALITIES

27.1 Equipment sizing Criteria

27.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

27.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

27.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application

		Water Velocity in m/sec		
	Pipe Size	**Below 50 mm**	**50-150 mm**	**200 mm & above**
a)	Pump suction	-	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	-	1.5 - 2.4	2.1 - 2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 M/Sec inside the pipelines at pump discharge.

Pipe line under gravity flow shall be restricted to a flow velocity of 1 M/sec generally Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 M/sec.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air = 15M/sec. (under Average Pressure & Temp. conditions)

27.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.

27.1.5 Based on the inside diameter so established, thickness calculation shall be made as per ANSI B 31.1. OD and thickness of pipes shall then be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.

27.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.

27.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.

27.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.

27.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.

27.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.

27.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.

27.1.12 Threaded joints shall be provided with teflon sealant tapes.

27.1.13 Following types of valves shall be used for the system/service indicated.

System	**Type of Valves**				
	Butterfly	**Gate**	**Globe**	**Check**	**Ball**	**Plug**
Water	x	x	x	x	x	
Air		x	x	x	x	
Drains & Vents			x	x	x	
Fuel oil		x	x	x	x	x

In water service, valves above 300 NB size may be butterfly valves.

27.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as required. The recirculation pipe shall be sized for minimum 30% design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

27.1.15 All piping 450 NB & above shall be designated as large dia piping.

27.2 Technical Specification

27.2.1 General

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Chapter. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/ anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/ supports, tanks etc.

27.3 Pipes and fittings

27.3.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness shall be adhered to. The bidder shall furnish the pipe sizing/thickness calculations as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

27.3.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

27.3.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and shall submit the detailed drawings for thrust/anchor block. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

27.3.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

27.3.5 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

27.3.6 Piping and fittings shall be manufactured by an approved manufacturer. They shall be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

27.3.7 For rubber lined ERW pipes, beads shall be removed.

27.3.8 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.

27.3.9 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.

27.3.10 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valves on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

27.4 **Material**

27.4.1 Alternate materials offered by bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the bidder and any standard code required for establishing the same shall be in English language.

27.4.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.

27.4.3 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.

27.4.4 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.

27.4.5 Material of construction for pipes carrying various fluids shall be as follows:

1	Raw water, Ash water, Circulating Water (CW), Aux. Cooling water (ACW), clarified Water, CW blow down, *Effluent disposal, service water, AHP Seal Water, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. At road crossings live loads shall be considered and pipe thickness shall vary accordingly. 150 NB & above pipes shall be spiral welded.
2	Dematerialized water, (condenser Make up water,	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm

	Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
3.	*Drinking (potable) water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
4.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
5.	Fuel Oil piping	API5L

NOTE: Bidder to note that for Effluent disposal system and potable water system (* marked) Ductile Iron (DI) pipes conforming to IS 8329 and for fittings IS 9523 can be offered as an alternate to the mild steel/ galvanized mild steel pipes as specified above for standalone or outside plant boundary stretches. Various design aspects of DI piping is mentioned in Annexure-I.

27.4.6 In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS: 1239 Grade heavy except for dematerialized water, drinking water and condensate spill lines.

27.4.7 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).

27.4.8 In dematerialized water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.

Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e., dimensions, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.

27.4.9 Instrument air, service air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than Heavy grade, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).

27.4.10 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.

27.4.11 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard'' as minimum to be maintained.

27.4.12 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.

27.4.13 Buried CW Pipes shall be encased in 500 mm thick RCC. However this thickness shall be reviewed for live loads at road crossings according to AWWA M11 and adequately revised.

27.5 Piping Wall Thickness

27.5.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.0 mm shall be considered while selecting the thickness.

27.5.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	20 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm to 1400 mm	-	12.0 mm
> NB 1400 mm to 1600 mm	-	14.0 mm
> NB 1600 mm to NB 2200 mm	-	16.0 mm
> NB 2200 mm	-	18.0 mm

27.6 Piping Layout

27.6.1 Piping shall be grouped together where practicable and routed to present a neat appearance.

27.6.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.

27.6.3 Over head piping shall have a normal minimum vertical clearance of 2.5 M above walkways and working areas and 8 M above roads/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

27.6.4 Pipelines of NB 50 size and below are regarded as field run piping. It is bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved for the installation of the field run pipe work. Based on these approved layouts, the bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.

27.6.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.

27.6.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.

27.6.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.

27.6.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.

27.6.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.

27.6.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

27.7 **Slope/Drains and Vents**

27.7.1 Suitable slope shall be provided for all pipelines towards drain points. It is bidder's responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vents shall not be less than 25 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.

27.7.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

27.8 **Pipe Joints**

In general, all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

27.8.1 **Screwed Joints**

(a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS: 554 unless specified otherwise.

(b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes an fittings are already galvanized before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above.

(c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.

(d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pasts. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.

(e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

27.8.2 **Welded Joints**

(a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

27.8.3 **Flanged Joints**

(a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.

(b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.

(c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

27.9 **Bends/elbows/mitre bends/Tees/Reducers & other fittings**

27.9.1 Unless otherwise specified elbows shall be of long radius type.

27.9.2 For pipe sizes 50 NB and below, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.

27.9.3 For steel pipes 65 NB and above, seamless long radius forged elbows shall be used. For pipe sizes 250 NB and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 degree bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS:2633/BS:534.

27.9.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.

27.9.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of

compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.

However, for pipes upto 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.

For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.

27.9.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes upto and including 50 mm NB, i.e. the fitting shall be of seamless construction.

However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.

27.9.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.

27.10 **Flanges**

27.10.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.

27.10.2 All flanges and-flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.

27.11 **Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in genera, shall be laid with the top of the pipe minimum 1 M below finished ground level.

27.11.1 **Trenching**

(a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822 or any international standard.

(b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.

(c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.

(d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.

(e) Coating and Wrapping shall be done as under.

27.11.2 **Preparation and cleaning of piping**

(a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.

(b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.

(c) On the internal surface for pipes 1000 NB and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied.

(d) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 250 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

27.11.3 **Coating and wrapping/ Anti corrosive Protection Coal tar tape**

a. Buried piping shall be coated and wrapped, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are:

(1) Coating primer (coal tar primer)
(2) Coating enamel (coal tar enamel)
(3) Wrapping materials.

All primer/coating/wrapping materials and methods of application shall conform to IS: 10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.

Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated Kraft outer wrap or finish coat.

Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of Coats and wraps shall be decided based on soil corrosivity/resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available.

Total thickness of completed coating and wrapping shall not be less than 4 mm.

b. Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to IS:15337 or equivalent. These-tapes shall be applied hot over the cold coal tar primer in steps of 2 mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of the finished protective coating shall be 4.0 mm min.

27.11.4 **Trench bed preparation and back filling**

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

27.11.5 **Laying of galvanized steel (GI) pipes**

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

27.12 **Cleaning and Flushing**

27.12.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

27.12.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.

27.12.3 After erection, all water lines shall be hydro tested at 1.5 times the design pressure.

27.12.4 All compressed air pipe work shall be cleaned by blowing compressed air.

27.13 **Painting of Pipes**

27.13.1 **Buried Piping**

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application: Bond/ Adhesion test, Holiday test

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

(iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

(iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

as per PBC, corrigendum 5, pg 114, sl. no. 31: The thickness of pipe shall be selected accordingly. Buried CW piping under rail / road crossing only shall be encased in 500 mm thick RCC/Culverts. The painting / protection of pipes (buried & overground) shall be in line with Clause 27.13, Chapter 27, Volume III of specification. However RCC encasing mentioned in this clause is not applicable.

NOTE: CW piping shall be encased in 500 mm thk RCC. Pipes external surface shall be applied with one coatsof coal tar primer before placing the pipes in position for RCC encasing. Thickness of paint shall be minimum 35 microns.

Tests to be carried out after application: Bond/ Adhesion test, Holiday test.

Overground Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

External surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat - Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 140 microns (min).

27.13.3 **Other requirements**

(a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.

(b) The color of the finish paint shall be as per approved color-coding.

(c) If finish paint is applied in shop, one coat of finish paint shall be applied at site.

(d) The dry film thickness of paint shall not be less than 0.15 mm.

27.13.4 **Color code for identification**

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

27.14 **Specification for hangers and supports**

27.14.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

27.14.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

27.14.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.

27.14.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062 or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS: 4360. Insulation protection saddles shall be used at support point of all insulated piping.

27.14.5 The support shall be interspaced as to minimize sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.

27.14.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

27.14.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.

27.14.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.

27.14.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.

27.15 **Design/Construction/Material Particulars of Gate/ Globe/ Check Valves/ Butterfly Valves**

27.15.1 **General**

(a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.

(b) General requirement of valves are as indicated below:

(1) The valves as well as all accessories shall be designed for easy disassembly and maintenance.

(2) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.

(3) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.

(4) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.

(5) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.

(6) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.

(7) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.

(c) The actuator-operated valves shall be designed on the basis of the following:

(1) The internal parts shall be suitable to support the pressure caused by the actuators.

(2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.

(3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.

(4) All actuators operated valves shall open/close fully within time required by the process.

(d) Valves coming under IBR shall meet IBR requirements.

(e) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:

(1) Hand wheel

(2) Position indicator (for above 50 mm NB valve size)

(3) Draining arrangement wherever required.

(f) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.

(g) Check valves shall be used for non-return service. They shall be swing check type or Dual plate type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.

(h) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.

(i) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

(j) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

(k) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary platforms for facilitating easy valve operation shall be provided wherever necessary.

(l) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.

(m) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

27.15.2 **Valve Body Material**

Valve body material for various services shall be as follows:

Valve body material for water application like circulating water, Secondary circuit auxiliary cooling water of ECW system, Raw water, Ash water make-up, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65 NB and above; gun-metal for sizes 50 NB and below.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water : SS body and disc alongwith SS internals.
Condensate : Cast Carbon Steel/Forged Carbon Steel.

27.15.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes n the locality where the valves will be installed.

The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504	Rubber seated butterfly valves
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.
BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

27.15.2.2 **End Connections**

The end connections, shall comply with the following:

Socket welding (SW)	–	ANSI B 16.11
Butt Welding (BW)	–	ANSI B 16.25
Threaded (SC)	–	ANSI B 2.1
Flanged (FL)	–	ANSI B 16.5 & AWWA-C-207

27.15.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections.

27.15.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.

27.15.2.5 All gun metal body valves shall have screwed ends.

27.15.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

27.16 Check Valves

27.16.1 Check valves shall comply with the following characteristics:

(a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
(b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.

(c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.

27.16.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.

27.16.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.

27.16.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

27.17 Globe Valves

27.17.1 The globe valves shall have the following characteristics:

Straight conveyed flow; Right angle; Preferably, the valves shall be of the vertical stem type.

27.17.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

27.17.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.

27.17.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

27.17.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

27.18 **Gate valves**

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

27.19 **Air Release Valves**

(a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.

(b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.

(c) Body material of automatic air release valves shall comply generally with IS: 210 Gr. FG 260 and spindle shall conform to high tensile brass.

(d) Air release valves shall not have any integral isolation devise within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

125# ASA cast iron body, double ball construction air release valve with flanged ends to ASA B 16.10; and bolted cover to release the air.

Construction materials shall be as below:

Body, cover	:	Cast iron to IS: 210 Gr.FG 260
Bolts	:	Light weight leather/wooden balls
Seats	:	SS
Cover packing	:	Braided asbestos
Float	:	Wood/rubber

27.20 **Butterfly Valves**

27.20.1 **Design/Construction**

The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 NB diameter. In such a case, however, the

bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.

(1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.

(2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.

(3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.

(4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

(5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

(6) The operating mechanism shall be mounted directly on or supported from the valve body.

(7) All valves shall be complete with:

Position indicator (located in a visible place)
Arrow indicating the flow direction;
Adjustable mechanical stop limiting devices to prevent over
Travel of valve disc in open/close position.
All valves shall be "tight shut off''

(8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 NB and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 NB and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

27.20.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni CI IS 210 Gr FG 260
Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber

(b) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304
Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/ Eq.
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Eq
Disc & Seat Rings	EPT/BUNA-N/Neoprene

27.20.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shaft generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

27.21 **Material Of Construction (Gate/Globe/Check Valve)**

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves

Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return	ASTM A 216 Gr. WCB/
Trim.	ASTM A 182 Gr. F6 or Equivalent

(2) Stainless Steel Valves

Body & Bonnet/Disc	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body

(3) Cast Iron Valves

Body & bonnet	IS-210 Gr. FG 260
Seating surfaces and rings	13% chromium steel/13% Chrome overlay
Disc for non-return valves	IS-210 Gr FG 260
Hinge pin for NRV	AISI 316
Stem for gate globe valves	13% chromium steel or Equivalent
Back Seat	13% chromium steel / 13% Chrome overlay

(4) Gun Metal Valves

Body and bonnet	IS 318 Gr. 2/Eq.
Trim	IS 318 Gr. 2/Eq.

(b) Cast iron body valves shall have high alloy steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

27.22 **Float Operated Valves**

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) Design And Construction Features

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 260, and float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5M/sec.

(h) The valves shall have flanged connections.

27.23 **Painting Of Valves**

Two (2) coats of primer followed by two (2) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be minimum 150 microns. If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel.

27.24 **Rubber Expansion Joints**

27.24.1 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.

27.24.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.

27.24.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60^0 A for outer and 50^0 A for inner cover.

27.24.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.

27.24.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.

27.24.6 Expansion joints shall be complete with stretcher bolt assembly. Expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.

27.24.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.

27.24.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.

27.24.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.

27.24.10 Expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.

27.24.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.

27.24.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

27.24.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

27.24.14 Bidder to note that any metallic part which comes in contact with DM/ Corrosive water shall be of stainless steel material.

~~27.25~~ ~~**Strainers**~~

~~27.25.1~~ ~~**Simplex type**~~

~~The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:~~

(a)	Body	IS: 318, Gr. 2 up to 50 mm NB, and IS: 210 Gr. FG 260 above 50 NB (For DM water/ -Body: AISI 316 or equivalent)
(b)	Strainer Element	Stainless steel (AISI 316)
(c)	End connection	Screwed upto 50 NB, and flanged above 50NB

27.25.2 **Duplex type**

(a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.

(b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

Body	IS: 318, Gr. 2 up to 50 NB, and IS: 210, Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted for 65 NB and above.
Strainer element	Stainless steel (AISI 316).
End connection	Screwed up to 50 NB; flanged for 65 NB & above. Gasket shall be of full face type.

(c) The strainer shall have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.

(d) The size of the strainer and the flow direction will be indicated on the strainer body casting.

(e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

27.25.3 Two shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited.

ANNEXURE-I

SPECIFICATION FOR DUCTILE IRON PIPES, FITTINGS & SPECIALS

1.00.00 General

This specification covers the specific requirement of design, material, manufacture /fabrication, constructional features, inspection & testing, transportation, handling, laying, site testing and annual maintenance contract of Ductile Iron (DI) Pipes, Joints, fittings and specials.

2.00.00 Codes and Standards

The material, design, manufacture, dimensions, tolerances, mechanical properties, internal cement mortar lining, external zinc coating along with bituminous finished layer, inspection and testing of DI water pipes shall comply with the latest Indian Standard, "IS 8329 (Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage – specification)" or equivalent international standard unless otherwise specified elsewhere in this Technical Specification.

S. No.	Code No.	Code Title
1	IS 8329	Centrifugally cast (spun) ductile iron pressure for water, gas and sewage - specification
2	IS 9523	Ductile iron fittings for pressure pipes for water, gas and sewage - specification
3	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
4	IS 638	Specification for Sheet Rubber Jointing and Rubber Insertion Jointing
5	IS 12288	Code of practice for use and laying of Ductile Iron pipes
6	IS 11606	Methods of sampling of Cast Iron pipes and fittings
7	IS 455	Portland slag cement
8	IS 12330	Sulphate resisting Portland cement
9	IS 6452	Specification for high alumina cement for structural use
10	IS 6909	Specification for supersulphated cement
11	IS 8112	43 grade ordinary Portland cement
12	IS 1387	General requirements for supply of metallurgical materials
13	IS 1500	Methods for Brinell hardness test for metallic materials
14	IS 1608	Mechanical testing of metals – tensile testing

15	ISO 2531	Ductile iron pipes, fittings,accessories and their joints for water applications
16	ISO 4179	Ductile iron pipes and fittings for pressure and non-pressure pipelines – Cement mortar lining
17	ISO 4633	Rubber seals – Joint rings for water supply, drainage and sewerage pipelines – Specification for materials
18	ISO 8179	Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer
19	ISO 8179	Ductile iron pipes – External zinc coating – Part 2:Zinc rich paint with finishing layer
20	ISO 8180	Ductile iron pipelines – Polyethylene sleeving for site application
21	ISO 10802	Ductile iron pipelines – Hydrostatic testing after installation
22	ISO 10803	Design method for ductile iron pipes
23	ISO 16132	Ductile iron pipe and fittings – seal coats for cement mortar linings
24	AWWA M 41	Ductile iron pipe and fittings (guideline code for design, manufacturing, testing, jointing, laying& installation etc.)
25	BS EN 545	Ductile iron pipes, fittings,accessories and their joints for water pipelines – Requirements and test methods

3.00.00 **Ductile Iron Pipes**

3.01.01 Design Requirements: Pipeline shall be sized considering C value as 140 and velocity 2-3 M/sec.

3.01.01 Classification:

The class of DI pipes to be provided shall be as specified in the data sheet attached with this sub-section. The external diameter and wall thickness of socket and spigot pipes for the specified Class shall be as per IS 8329 or equivalent international standard.

3.02.00 Joints:

3.02.01 Generally, push-on flexible joints shall be provided for pipe to pipe connection as per IS 8329 or equivalent international standard. However mechanical joints, flange joints and restrained joints can also be used.

3.02.02 Rubber gaskets

Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382 or equivalent international standard. Rubber gaskets for use with flanged joints shall conform to IS 638 or approved equivalent international standard.

4.00.00 **Di Fittings & Specials**

4.01.00 The DI fittings shall be as per IS 9523 or equivalent International standard.

4.02.00 External layer: The DI fittings supplied shall be provided with external protection of metallic zinc coating or zinc rich paint coating with finishing layer of bituminous paint as per IS 9523 or equivalent international standard.

4.03.00 Internal lining: The fittings shall be provided with suitable cement mortar internal lining as per IS 9523 or equivalent international standard.

4.04.00 Joints between pipe and fittings:

4.04.01 Generally, Push-on flexible joints shall be provided for pipe to fitting connection as per IS 9523 or equivalent international standard. Flange joints, wherever required, shall conform to the requirements of IS 9523 or equivalent international standard.

4.04.02 Rubber gaskets

All the Dl fittings shall be provided with rubber gaskets for each socket. Rubber gasket used with push-on flexible joints shall conform to the requirements of IS: 5382/ IS 9523 or equivalent international standard.

Rubber gaskets for use with flanged joints shall conform to IS 638 or equivalent international standard.

5.00.00 **Type Tests**

5.01.00 The manufacturer shall carry out the type tests as listed in this specification on the pipes to be supplied under this contract.

5.02.00 The type tests shall be carried out in presence of the Employer's representative. The contractor shall obtain the Employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

5.03.00 In case the manufacturer has already conducted such specified type test(s), he may submit the type test reports during detailed engineering for consideration of waiver of conductance of such type test(s) or otherwise. Such test(s) should have been either conducted at an independent laboratory or duly approved by accredited third party agency. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract.

5.04.00 The type test shall be performed whenever a significant change is made in the design, material or process of manufacture or a new size or size range of the product is being supplied by the manufacturer.

5.05.00 **Type Tests**

5.05.01 Joint Leak Tightness Test:

a) Tests for joints (push-on flexible joints) shall be conducted as per the guidelines of ISO 2531 to establish adequate joint performance with

respect to internal pressure, external pressure and vacuum pressure under both normal alignment of joints and deflected alignment of joints as dictated in ISO 2531.

b) Tests for Leak tightness and mechanical resistance of flanged joints shall be conducted as per ISO 2531.

5.05.02 Cement Lining Smoothness Type Test:

The manufacturer should have carried out Cement Lining Smoothness test to establish C value (Hazen & William's constant) of the offered DI pipe as 140. Necessary certificate for the same shall be furnished.

In case the contractor / manufacturer has not carried out the test, the same shall be carried out by the contractor / manufacturer within the scope of this contract.

5.05.03 Ring bend test:

Ring bend test for 3% deflection with respect to external diameter of DI pipe offered shall be conducted by contractor / manufacturer to prove that internal cement mortar lining does not come off the substrate surface of Ductile Iron on random basis for each manufacturing lot.

If the contractor / manufacturer of pipes do not have the facility for this type test at his own works, the same can be arranged by him to conduct and demonstrate the test.

6.00.00 **Laying and Jointing Of DI Pipes:**

6.01.00 Laying, erection and jointing of DI pipelines at field / site shall be under the direct supervision of Manufacturer (Supplier) from whom pipe is sourced/ procured.

For underground laying, special provisions in trench shall be made for accommodating socket (bell) of each pipe, as applicable so that barrel is uniformly rested on even trench bed surface, which is well compacted as recommended in codes / standards.

6.02.00 Pipeline anchorage

Pipeline shall be securely anchored at dead ends, tees, bends, tapers and valves to resist thrust arising from internal pressure. Suitable thrust blocks made of concrete shall be designed and cast-in-situ.

7.00.00 **Hydraulic Testing Of Pipelines**

7.01.00 After laying and jointing, the pipeline shall be tested for soundness and leak tightness of pipes, fittings and joints, and soundness of any construction work. The pipeline may be tested in sections.

7.02.00 Hydraulic Testing of Sections

The section under test shall be filled with water, taking care that all the air is displaced either through vents at the high points or by using a pig or a sphere. After filling, the pipeline shall be slightly pressurized for a period of time to achieve stable conditions.

The pipeline is then pressurized up to the full test pressure as per the relevant standard. The test pressure shall be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joints or anchorages. The test pressure shall be measured such as to ensure that the required test pressure is not exceeded at any point in the entire pipeline.

If the test is not satisfactory, the fault shall be found and rectified. Methods employed for finding faults shall be as per IS 12288.

7.03.00 Hydraulic Testing of Complete Pipeline

After all the sections have been joined together on completion of section testing, a test on the complete pipeline shall be carried out. This test shall be carried out at a pressure as specified in the data sheet attached with this sub-section. During the test, the pressure at any point in the pipeline shall not exceed the pressure as specified in the data sheet attached with this subsection.

DATA SHEET

S. No.	Description	Units	Parameters
1	Pipe Material		Ductile Iron (DI) pipe internally cement mortar lined and externally coated with metallic zinc & finishing layer of bituminous paint.
2	Applicable standards		IS/ISO/AWWA/BS as listed in technical specification
3	Hazen & Wliiam's Constant		140
4	Pipe class		K7/K9 as per IS 8329 or equivalent international standard. Compatible with system pressure requirement.
5	Pipe Joint type		Push-on flexible joints as per IS 8329 / Flanged/ Restraint
6	Pipe Joint type at valves, pumps and other piping		Flange Joints as per IS 8329 & IS 9523
7	Welded-on Flange (as applicabe) pressure class		Compatible with system pressure requirement.
8	DI fittings class		Compatible with system pressure requirement.
9	DI fittings flange (as applicable) class		PN 25
10	Restrain mechanism at bends, specials etc.		Thrust Blocks
11	Maximum field hydrostatic test pressure	N/mm^2	Shut-off pressure or (opearating pressure+surge pressure) whichever is higher for not less than 10 minutes
	At each section (not exceeding 1000m)		
	Complete pipeline		As per IS: 12288 Table-1
12	Other requirements		As per technical specification

TECHNICAL SPECIFICATION
FOR
NATURAL DRAUGHT COOLING TOWER

(ELECTRICAL PORTION)

1.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:**

a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Erection and Commissioning spares.
e) Erection & Maintenance tools & tackles.
f) Electrical load requirement for NATURAL DRAUGHT COOLING TOWER.
g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
i) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
j) Motor shall meet minimum requirement of motor specification.
k) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.
l) Technical specifications attached as enclosures to be referred only for applicable packages as mentioned in the scope "Electrical scope between BHEL & vendor"

2.0 **EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this signed and stamped copies of the following shall be furnished by the bidder as technical offer:

a) A copy of this sheet ”Electrical equipment Specification for NATURAL DRAUGHT COOLING TOWER” and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.
b) Electrical load requirement

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures :

4.1 Section-C

4.2 Electrical scope sheet between BHEL & Vendor
4.3 Customer Specification for AC & DC Motors
4.4 BHEL specification for Motors
4.5 Cable Schedule Format
4.6 Electrical Load Data Format
4.7 Customer Specification for Cables
4.8 Customer Specification for Cabling system
4.9 Customer specification for Earthing & Lightning Protection
4.10 Customer Specification for Illumination/ Lighting and Aviation lighting
4.11 QP for LV motors
4.12 QP for LT power cables
4.13 QP for Cable trays and accessories
4.14 QP for cable tray support system (Boltable type)
4.15 Above Ground Earthing and lightning protection materials
4.16 QP for Lighting Fixtures, lamps & misc. items
4.17 QP for Distribution Boards
4.18 List of approved Galvanizers

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

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 3Phase 3Wire. Vendor to provide requirement of Emergency Power Supply for their use, if any, 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, please refer remarks in S.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) *Refer Note below:	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation dwgs by vendor. 2. BHEL will provide cable trench/cable racks/cable padestals along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands ,lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.

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Note: Please note that Supply & E&C of 'structural steel' for supporting cabling material shall be in 'Vendor's scope".

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
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	Vendor	Vendor	Vendor shall consider lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires/cables (from LP onward), any other material required for lighting system shall also be considered by vendor in their scope. **BHEL will provide the power supply along with LDB at one location near Cooling Tower for feeding cooling tower vendor LPs. Further, distribution including material is in vendor scope.** R1
12	Aviation Lighting	Vendor	Vendor	Vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires/cables (from LP onward), any other material required for Aviation lighting system shall also be considered by vendor in their scope. **BHEL will provide the power supply along with LDB at one location near Cooling Tower for feeding cooling tower vendor LPs. Further, distribution including material is in vendor scope.** R1
13	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
14	**Engineering activities** during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical

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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
	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			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.

26/08/2019 26/08/19 28/8/19 28/8/19

CHAPTER – 16

AC & DC MOTORS

16.01.00 **SCOPE**

This chapter covers design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

16.01.01 Site Conditions

Site conditions are covered in 'General Project Information', contained in specification of the driven equipment.

16.01.02 Gases, Fumes & Dust Particles

General – Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

16.01.03 Dust Particles

i) Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

ii) Indoor Locations.

iii) Coal conveyors - As for outdoor as per clause 16.01.03 (i) above.

iv) Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

16.01.04 Special Fumes

i) Water treatment plant and acid cleaning room - Acid and alkali fuses present.

ii) Fuel oil pumping areas & Hydrogen generation plant - Explosive fuses (flameproof motors required).

iii) For the purpose of design of equipment/systems, an ambient temperature of 50^0C and relative humidity of 95% (at 40^0C) shall be considered. The equipment shall operate in a highly polluted environment.

16.02.00 **LOCATION OF MOTORS -** As required

16.03.00 **CODES AND STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as mentioned in Chapter 37 except where modified and/or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

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

16.04.00 **TYPE**

16.04.01 AC Motors:

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

ii) Continuous duty LT motors rated above 0.37kW up to 160 KW Output rating (at 50^0 C ambient temperature), shall be **Efficiency class-IE3**, conforming to IS 12615, or IEC:60034-30. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

iii) Crane, hoist & elevator duty motors shall be squirrel cage Induction motor of S4 duty and 40% CDF or VFD motors.

16.04.02 DC Motors

i. D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.

ii. Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

16.04.03 VFD Motors

i. Induction motors to be operated in adjustable-speed drive applications should be derated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.

ii. Inverter duty motors shall be self-ventilated without any auxiliary blower. Force ventilation shall be subject to Owner approval.

iii. Inverter duty motors shall have VPI insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.

iv. Inverter duty motors are designed according to the requirements of IEC 60034 Part-17 & Part-25 or NEMA MG-1, Part-30, Part-31 and have performance characteristics match with the driven equipment and variable speed requirement.

v. The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies.

vi. The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.

vii. The motor shall be provided with insulated bearing on one side.

viii. Normally the maximum safe speed shall be as per IEC/NEMA, however it should be coordinated with VFD requirement.

16.05.00 **VOLTAGE (NOMINAL)**

16.05.01 LV Motors

For motors up to and including 160 KW - Four hundred fifteen (415) V.

16.05.02 MV Motors

For motors above 160 kW up to and including 1500kW - Six-point six (6.6) kV.

16.05.03 HV Motors

i) For motors above 1500kW - eleven (11) KV
ii) All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

16.06.00 **FREQUENCY (NOMINAL)** - fifty (50) Hertz

16.07.00 **NUMBER OF PHASES** - Three (3)

16.08.00 **SPEED** - As required by the driven equipment

16.09.00 **TYPE OF STARTING** - Direct on-line

16.10.00 **DUTY**

16.10.01 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency and voltage variation. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

16.10.02 Motor rating shall be such that it is not overloaded at any operating point of driven equipment from zero to full load.

16.10.03 The break-away torque, pull-up torque and pull-out torque of the motors shall be properly coordinated with the requirements of driven equipment to ensure smooth and rapid starting and steady operation. The torque-speed characteristic of motor super imposed thereon on driven equipment torque-speed characteristics at 100%, 90%, 80% shall be furnished.

16.10.04 All HV & MV motors shall be provided with vibration pads for mounting vibration detectors.

16.10.05 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.

16.10.06 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment at least twenty-five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.

16.10.07 HV & MV motors shall have full load efficiency of 95% minimum and rated full load power factor of 0.8 minimum. The required power factor shall be achieved without using external capacitor. Tolerance on this efficiency value shall be applicable as per IEC 60034. However, this is not applicable for geared motors (motors completely integrated with driven equipment) which are specifically designed to suit the driven equipment duty.

16.11.00 **SUPPLY VARIATIONS .....** Motors shall be capable of running continuously at full load under following variations in power supply.

16.11.01 Voltage (percent of nominal voltage) ……. Plus minus ($\pm$) ten (10) for LT
Plus minus ($\pm$) Six (6) for MV & HT

16.11.02 Frequency (percent of minimal frequency) ……. Plus Three 3 & minus (-) five (5)

16.11.03 Combined voltage & frequency (percent) ……. Ten (10) (sum of absolute percentage value of voltage and frequency variation)

16.12.00 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:-

16.12.01 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

16.12.02 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

16.12.03 Low Voltage Running: -

Motor shall be capable of running satisfactorily at seventy-five (75) percent nominal voltage for five (5) minutes.

16.12.04 Momentary Low Voltage Withstanding:

Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

16.13.00 **STARTING CAPABILITY**

16.13.01 Low Voltage Starting

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80) percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

16.13.02 Cold Motor Starting

Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at ambient temperature)

16.13.03 Hot Motor Starting

Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start shall be made till lapse of further thirty (30) minutes. (With initial temperature of the motor at full load operating level)

16.13.04 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

16.13.05 Break-away Starting Current

Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:-

i) Motors up to 1000 KW …… 600% subject to IS Tolerance of plus 20%

ii) Motors (above 1000 KW up to 3000 KW)…… 600%. Subject to 20% IS tolerance.

iii) Motors above 3000 KW……......450%. Not subject to any positive tolerance. For energy efficient

iv) LT motors, locked rotor current shall be as per IS: 12615.

v) Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance

16.13.06 Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.

16.14.00 **STARTING VOLTAGE REQUIREMENT**

16.14.01 All Motors (except Mill Motors)

i) 80% of rated voltage for Motors up to 4000 kW
ii) 75% of rated voltage for Motors above 4000 kW

16.14.02 For Mill Motors:

i) 85% of rated voltage for Motors above 1000 kW
ii) 90% of rated voltage for Motors below 1000 kW

16.15.00 **TORQUE REQUIREMENTS**

16.15.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.

16.15.02 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

16.16.00 **STARTING TIME**

16.16.01 For motors with starting time up-to 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.

16.16.02 For motors with starting time more than 20 secs. and up-to 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.

16.16.03 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.

16.16.04 At no stage, speed switch shall be provided to achieve requirements mentioned in Clause No. 16.16.01 to 16.16.03.

16.17.00 **CLASS OF INSULATION**

16.17.01 LV Motors ..... Class F.

16.17.02 HV & MV Motors ..... Class F

16.17.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both MV, HV & LT motors. The temperature under abnormal running conditions shall be limited to 5^{o}C above class ‘B’ limits.

16.17.04 The value of the polarization index for motors above 160kW should not be less than 2 when determined according to IS: 78114.0

16.17.05 For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages,

16.17.06 HT motors shall withstand 1.2/50 micro sec impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

16.18.00 **TEMPERATURE RISE UNDER NORMAL CONDITIONS**

16.18.01 Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S. No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
i)	50^0C	60^0C	70^0C

16.18.02 For Water Cooled Motors, temperature rise of insulation should be limited to 80 deg. C, over inlet cooling water temperature mentioned elsewhere, by resistance method.

16.19.00 **BUS TRANSFER WITHSTAND CAPABILITY**

Motors shall be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The manufacturer/ vendor shall indicate the special precautions taken to meet the above requirements and confirm.

16.19.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

16.19.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

16.19.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

16.20.00 **TYPE OF ENCLOSURE**

16.20.01 Outdoor Motors……. IP 55 (Additional canopy to be provided by Bidder).

16.20.02 Indoor Motors ..... IP 55

16.20.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

16.21.00 **METHOD OF COOLING**

16.21.01 Method of cooling 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)

16.21.02 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

16.22.00 **TYPE OF MOUNTING** ..... As required for the driven equipment.

16.23.00 **MAXIMUM MECHANICAL VIBRATIONS**

Vibration shall be limited within the limits prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HV & MV motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Vibration pads with screwed holes along with vibration probes shall be provided at both DE and NDE.

16.24.00 **NOISE LEVEL**

16.24.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). at 1m from operating motor measured in accordance with IS: 10265.

16.24.02 Motor body shall have two earthing points on opposite sides.

16.24.03 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE – I	
DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS	
Motor MCR in KW	**Minimum distance between centre of stud and gland plate in mm**
UP to 3 KW	As per manufacturer's practice.
Above 3 KW - up to 7 KW	85
Above 7 KW - up to 13 KW	115
Above 13 KW - up to 24 KW	167
Above 24 KW - up to 37 KW	196
Above 37 KW - up to 55 KW	249
Above 55 KW - up to 90 KW	277
Above 90 KW - up to 125 KW	331
Above 125 KW-up to 160 KW	203

16.24.04 For HV & MV motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

16.24.05 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.

16.24.06 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

16.25.00 **WINDING & INSULATION**

16.25.01	Type	:	Non-hygroscopic, oil resistant, flame resistant
16.25.02	11kV & 6.6 kV AC motors	:	Thermal class 155 (F) insulation and the temperature rise shall be limited to Class B. Winding material shall be F/B class electrolytic copper grade polymica insulated rectangular bar type copper conductor. The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & inter-turn insulation surge withstand level shall be as per IEC-60034 part-15
16.25.03	240VAC, 415V AC & 220V DC motors	:	Thermal Class(F)

16.26.00 **DIRECTION OF ROTATION**

16.26.01 As needed by driven equipment.

16.26.02 The 3-phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

16.26.03 If, in the case of HV & MV motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

16.27.00 **BEARINGS**

16.27.01 Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 40000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.

16.27.02 Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.

16.27.03 If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.

16.27.04 Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

16.27.05 For MV & HV motors rated 1000KW and above , the bearing housing shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

16.27.06 When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.

16.27.07 Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.

16.27.08 Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.

16.27.09 Bearings shall be of internationally reputed make subject to the approval of the Owner/Consulting Engineer.

16.27.10 Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.

16.28.00 **SHAFT EXTENSION** ..... Key slotted bare shaft extension of required length with key on driving end.

16.29.00 **DRAIN HOLES** ..... Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.

16.30.00 **LIFTING DEVICES** ..... Motors shall be provided with eye-bolts, lugs or other means to facilitate safe lifting.

16.31.00 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven equipment assembly) or at site after erection (for separate supplies of above equipment).

16.32.00 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.

16.33.00 **EASE OF MAINTENANCE**..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

16.34.00 **NAMEPLATES**..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:-

16.34.01 In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

16.34.02 Temperature rise under normal/abnormal conditions.

16.34.03 Type of bearing and recommended lubricants.

16.35.00 **FINISH**

16.35.01 Motor shall have synthetic enamel paint shade as mentioned in Chapter 1.

16.35.02 All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

16.36.00 **TERMINAL BOXES**

16.36.01 General

i) Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals, Neutral CT terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination cable to be finalized during detailed engineering.

ii) The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HV & MV motors shall be provided with phase segregated terminal box as per Cl 16.36.02 (ii).

iii) Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

16.36.02 Main Terminal Box

i) LV Motors ..... Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

ii) MV & HV Motors shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. For motors rated below 1000 KW should be interchangeable to facilitate cable routing. Alternately if elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided.

iii) Neutral terminal box for MV/HV motors rated 1000 KW and above shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These CTs shall be mounted in the motor neutral terminal box. Stator phase terminal box shall be phase segregated terminal box suitable for both top or bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable terminating Kit. Terminal leading shall be stud type or leading wire type.

iv) Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables. For 11/6.6kV motors 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 in case of cable boxes.

v) The terminal boxes shall be capable of withstanding at the terminals the system fault level (as mentioned in Data Sheet) without rupture for a duration of at least 0.25 seconds.

vi) Phase to Phase/ Phase to Earth Air Clearance: -

a) 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

vii) Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes.

16.37.00 **TYPE AND SIZE OF CABLES**

16.37.01 Space Heaters

i) For LV Motors: Two-point five (2.5) sq mm, two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

ii) For MV & HV Motors: Two-point five (2.5) sqmm two core copper conductor XLPE insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I). For higher rating HV/MV motors 3 phase space heater shall be used and cable size shall be 3Cx6 sqmm copper.

iii) For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm^2 ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm^2, ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).

iv) Bearing Temperature Indicators - For each indicator, 0.5 mm^2 six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.

v) For Moisture Detectors.....As for space heaters as per Clause 16.37.01 (i) above.

16.37.02 For Main Terminals: -

i) LT Motors

a) Three (3) core cables ……Stranded aluminium conductor, XLPE insulated, colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire / strip armoured, FRLS PVC type-ST2 jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).

b) Single core cables ……Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC type ST2 jacketed overall, 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

ii) HV & MV Motors

Three (3) core cables …… stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, FRLS PVC type ST2 sheathed, GI wire/strip armoured FRLS PVC type ST2 jacketed overall, 6.6 KV / 11 KV unearthed grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

16.38.00 **GROUNDING**

16.38.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

16.38.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors up to 5.5 KW) for size of conductor specified shall be provided.

16.38.03 HV & MV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

16.39.00 **EMBEDDED TEMPERATURE DETECTORS**

HV & MV motor shall be provided with four (4) Nos. simplex or two (2) Nos. duplex platinum resistance temperature detectors (RTDs) in each phase embedded in stator winding at locations where high temperatures are expected. In addition, one (1) duplex type RTD shall be provided in each bearing. 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 of dual input transmitters with display unit. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg C.

16.40.00 **BEARINGS TEMPERATURE INDICATORS**

HV & MV motors shall be provided with dial type two (2) bearing temperature indicators and shall have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set shall be set to

operate at lower value to give alarm and other set at a higher value to trip the motor.

16.41.00 **SPACE HEATERS**

16.41.01 Valve / Damper actuator motors; and Motors 30 KW and above shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple.

16.41.02 The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

16.41.03 The space heater shall be wired to maintain the motor internal temperature above dew point when the motor is in idle condition.

16.42.00 **HOT AIR TEMPERATURE DETECTOR**

If the motor is of CACA or CACW enclosure, dial type temperature indicator shall be provided (one each for hot and cold air temperature monitoring for CACA and CACW and one each for inlet and outlet water temperature monitoring for CACW). In addition, one (1) duplex type RTD shall be provided in each enclosure for alarm and if trip is required for cooling air temperature, temperature switch shall be provided.

16.43.00 **WATER FLOW INDICATOR**

If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits. In addition, one (1) duplex type RTD shall be provided in each water inlet and outlet circuit

16.44.00 **MOISTURE DETECTORS**

Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

16.45.00 **BED PLATE**

Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

16.46.00 **OTHER ACCESSORIES**

Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

16.47.00 **TESTS**

16.47.01 HV & MV Motors

i) Routine Tests

All equipment shall be completely assembled, wired, adjusted and all acceptance and routine tests as per the specification and relevant standards shall be carried out. These tests shall be carried out in presence of the Owner's representative, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price.

ii) Type Tests

a) For each type & rating of HV & MV motors the Bidder shall submit for Owner's approval the reports of all the type tests as per relevant standards. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been conducted at an independent laboratory. Period - Within 5 Years from the zero date.

b) In case the Bidder is not able to submit report of the type test(s) conducted,, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval, for which a minimum 7 days' notice shall be given by the Bidder. Charges for these shall be deemed to be included in the equipment price

iii) List of minimum type tests to be conducted

The following Minimum type tests shall be conducted on each type and rating of HV & MV motor:-

a) No load saturation and loss curve up to 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) IR + PI

f) Partial Discharge

g) Winding resistance

h) 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 ETDs are provided, the temperature shall be measured by ETD's also for the record purpose. In case due to test bed limitations at the manufacturing works, mixed frequency method as per latest IEC 60034 is also acceptable.

i) Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15

j) Surge-withstand test on interturn insulation shall be as per IEC60034, part-15

k) Degree of protection test for the enclosure followed by IR, HV and no-load run test.

l) Terminal box-fault level withstand test for each type of terminal box.

m) 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.

16.47.02 LT Motors

i) Routine Test

All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant IS/IEC Standards at manufacturer's works in the presence of Consultant /Owner or his representative.

ii) List of minimum tests for which reports have to be submitted

The following minimum type test reports shall be submitted for each type and rating of LT motor of above 30 KW only

a) Measurement of resistance of windings of stator and wound rotor.
b) No load test at rated voltage to determine input current power and speed.
c) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
d) Full load test to determine efficiency power factor and slip.
e) Temperature rise test.
f) Momentary excess torque test.
g) High voltage test.
h) Test for vibration severity of motor.
i) Test for noise levels of motor(Shall be limited as per clause No. 1.24.00 of this section)
j) Test for degree of protection and
k) Over speed test.

l) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

iii) 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.

16.48.00 **INFORMATION WITH PROPOSAL**

16.48.01 AC Motor Data Sheet.

16.48.02 Dimension Drawing/Foundation load details of motor and driven equipment.

16.48.03 Manufacturer's catalogue showing constructional details.

16.49.00 **INFORMATION ON AWARD OF CONTRACT**

16.49.01 Motor Data Sheet

Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

16.49.02 Following characteristics curves: -

i) Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment except for mill motor. For mill motor torque speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment

ii) Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current speed curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage

iii) Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor current time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

iv) Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor thermal withstand curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

v) Efficiency, power factor, current and speed versus power output curves.

vi) Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage except for mill motor. For mill motor speed time curve for motor at ninety (90) hundred (100) and hundred ten (110) percent rated voltage.

vii) Negative phase sequence current withstand characteristics.

16.50.00 **DC MOTOR**

16.50.01 D.C. Motor provided for emergency service shall be shunt / compound would type. The starting current shall be as per manufacturer's standard.

16.50.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

16.50.03 Starter panel complete with all accessories shall be included in the scope of supply.

16.51.00 **DRAWINGS, DATA & MANUALS**

16.51.01 Minimum Drawings, data & manuals for the motors to be submitted

i) Dimensional General Arrangement drawing
ii) Foundation Plan & Loading
iii) Cable end box details
iv) Space requirement for rotor removal
v) Thermal withstand curves hot & cold
vi) Starting and speed torque characteristics at 80% & 100% voltage except for mill motor. For mill motor Starting and speed torque characteristics at 90% & 100% voltage.
vii) Complete motor data
viii) Erection & Maintenance Manual
ix) Test reports
x) QAP

DATASHEET

	Auxiliary power supply	
1.1	**HV supply**	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed Earthed through resistance, limiting earth fault current to 400 Amps	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
	HV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.2	**MV supply**	
	6.6kV, 3Φ, 3W, 50 Hz non effectively earthed. Earthed through resistance, limiting earth fault current to 400 Amps	Motors above 160kW up to and including 1500kW
	Fault level	40 kA for 1 second
	MV Motors	shall be controlled through vacuum circuit breaker
	The cooling tubes of Motor	Shall be of Stainless Steel
1.3	**LV supply**	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 160kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
	LT motors rated up to 90 kW	shall be controlled through MPCB/ MCCB and contactor.
	LT motors rated more than 90 kW	Shall be controlled through air circuit breaker
1.4	**DC supply**	
	220V,2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	------
	Frequency	------
	Combined voltage & frequency	--------
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

1.0 INTENT OF SPECIFIATION

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

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

2.0 CODES AND STANDARDS

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

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

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

3.0 DESIGN REQUIREMENTS

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

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

3.3 Starting Requirements

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

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

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

CLAUSE NO.	Bidder's Name ……..

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	

	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	

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 ……..	

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)	

	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	

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 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		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

CHAPTER – 20

LV POWER CABLES

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CHAPTER – 20

LV POWER CABLES

20.01.00 **SCOPE OF SUPPLY**

20.01.01 The LV Power cables shall be supplied, installed and commissioned in accordance with the following specification.

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

20.02.00 **CODES & STANDARDS**

20.02.01 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on zero date. 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 standards listed in Chapter 37.

20.02.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted subject to approval of the Owner. In such case, copies of the English version of the standards adopted shall have to be submitted along with the bid.

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

20.03.0 **DESIGN CRITERIA**

20.03.01 The cables shall be used for connection of power circuits of the system. Actual cable sizes shall be selected based on approved sizing calculations. Number of different sizes selected shall be kept to a minimum for optimization. Preferred cable sizes are mentioned in Annexure A.

20.03.02 Cables shall be generally laid on ladder type cable trays. For interplant connection cables shall be routed along overhead cable bridge.

20.03.03 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification.

20.03.04 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

20.03.05 The inner and outer sheath shall have flame retardant low smoke (FRLSH) characteristics or fire survival characteristics as the case may be and shall meet the requirements of additional tests specified for the purpose.

20.03.06 Core identification for multicore cable shall be provided by colour coding.

20.03.07 Cables shall be so designed and manufactured that no damage occurs during handling, transit, storage, installation under any operative conditions which they may be subjected to.

20.03.08 Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition. 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 shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

20.03.09 Power cables shall be chosen taking into account the factors mentioned in Chapter -1.

20.04.00 **SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS**

20.04.01 1.1KV Aluminium Conductor Power Cables

i) 1100 volt, 90 Deg. C rating, heavy duty power cables with stranded aluminium conductor, extruded XLPE insulation, extruded PVC,FR-LS inner sheath, aluminium round wire armour for single core cables and galvanized steel strip /wire armour for three (3) core cables, and extruded PVC, FR-LS overall sheath. Cables shall be manufactured in conformity to IS-7098 part 1 - 1988, amended up to date and bearing ISI mark.

iii) Conductor

The cable conductor shall be made from standard Aluminum of grade H2 and Class 2 to form compact conductor having a resistance within the limits specified. All the cables of size 25mm2 and above shall have sector shaped conductors.

iv) Insulation

The insulation shall be XLPE type. It shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The insulation of the cables shall be of high standard quality.

v) Inner Sheath

a) The laid up insulated cores of twin and multicore power cables shall be provided with an inner sheath of extruded FRLSH PVC, compound conforming to Type ST2 of IS:5831. Single core power cables need not be provided with any inner sheath.

vi) Armour

a) For single core armoured cables, armouring shall be of aluminium wires/formed wires of H4 grade.

b) For multicore armoured cables, armouring shall be of galvanised steel strip /wire.

vii) Overall Sheath

a) Outer sheath shall be of extruded FRLSH PVC compound conforming to type ST2 as per IS: 5831 & black in colour. In addition to meeting all the requirments of Indian standards referred to, outer sheath of all the cables shall be applied with anti rodent and termite additives. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLSH properties.
(i) Oxygen index of min. 29
(ii) Acid gas emission of max. 20% as per IEC-754 (Part-I)
(iii) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

20.04.02 1.1KV Grade Copper Conductor Fire Survival Power Cables

i) 1100 volt grade, 90 Deg. C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984. The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988. The cables can withstand 750 Deg. C temperature for three (3) hours.

ii) Conductor

a) Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.

b) A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

iii) Insulation

a) Cores of the cable shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue & Black

iv) Laying up of cores (For multi core cables only)

a) The core shall be suitably identified in accordance with IS: 9968 (Part-I).

b) The suitable fire retardant material fillers shall be used for filling in the interstices.

c) Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

v) Inner Sheath

a) An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fiber tape over the insulation.

vi) Armour

a) For Single core cables to be used in A.C system, the armouring over inner sheath shall consist of single layer of round copper wire.

b) For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.

vii) Outer Sheath

a) The extruded outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

b) Minimum value of 'Tensile Strength' and 'Percentage elongation rat rupture' shall be 8 Newton/Sq. mm and 250% respectively.

c) The colour of outer sheath shall be black or any other colour agreed mutually between Owner and Supplier.

20.04.03 Flexible Trailing Cables

1100 V Grade flexible trailing cable shall be tinned copper of Class – 5 of IS – 8130, heat resistant electrometric compound based on EPR insulation, inner sheath of heat resistant electrometric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty electrometric compound FRLSH CSP outer sheath.

20.05.00 **GENERAL REQUIREMENTS**

20.05.01 Drum Length & tolerance

i) Cable shall be supplied in wooden drums. The standard drum length of LT power cable 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 750 meter for multicore cable & single core 630 sqmm.

ii) 1.1KV Copper Fire Survival Power cables shall be supplied in wooden drums. Each drum shall be minimum 750 metres single length of cable to ensure that there is no joint in the cable.

iii) Allowable tolerance on individual drum length is (±) 5%.

iv) The drums shall be designed based on weight, diameter, bending radius, and length of the cable. The surface of drum and outermost cable layer shall be covered with waterproof material. Both the ends of the cables shall be properly sealed to eliminate ingress of water during transportation, storage and erection.

20.05.02 Non-standard length

One drum length of each cable size can be of non-standard length (not less than 250 metres) subject to the condition that there shall not be any joint in the cable.

20.05.03 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

a) HPGCL
b) Manufacturer's name or trademark
c) Voltage grade
d) Year of manufacture
e) Type of insulation and sheath, e.g. XLPE /PVC FRLSH, IE2/SE3 F.S. as applicable.
f) No. of core and size of cables.
g) Sequential length marking at an interval of 1m through out the length of the cable.
h) ISI mark with C/ML Number
i) Type of improved fire performance, e.g. FR/FR-LSH/FS.

20.05.04 Packing

i) Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden drums shall be treated by immersing in copper nitrate solution

ii) Cable shall be wound and packed on drums in such a manner that it shall be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose

iii) A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions

shall be marked on the drum indicating the direction in which it should be rolled. Drum numbers are to be indicated on cable drums.

iv) The cable drums should carry the following details in printed form (non-returnable): -

a) HPGCL & Manufacturer's name or trade make
b) Type of cable & voltage grade
c) Year of manufacture
d) Type of insulation / sheath e.g. XLPE /PVC FRLSH, IE2/SE3 F.S. as applicable.
e) No. of core and size of cables
f) Cable code
g) Length of cable on drum
h) Direction of rotation, by arrow
i) Approx. gross mass.
j) ISI mark
i) IS/IEC number

20.06.00 **TESTING PROCEDURE**

20.06.01 Tests During Manufacture: -

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to Owner's representative during inspection / testing.

20.06.02 Type Tests: -

i) Cables shall be type tested quality. For each type and rating of cables reports on all type tests as per relevant standards, and carried out with in last five years from the zero date shall be submitted.

ii) These reports shall be for the tests conducted on the similar type of cables proposed to be supplied under this contract. These tests should have been conducted from Govt. recognized Lab with in last 5 years from the zero date. If type test certificate are not available or in the case of type test report(s) are not found to be meeting the specification requirements, the same shall be conducted in the presence of the Owner free of cost.

iii) The following type tests shall be submitted: -

S. No.	Test	Reference Standard
1	Test on conductor	IS: 8130
2	Thickness of insulation & sheath	IS: 7098 (P-1)
3	Physical test on Insulation	IS: 7098 (P-1)
4	Physical Test on Outer Sheath	IS: 5831

S. No.	Test	Reference Standard
5	Ins. Resistance (Vol. Res.)	IS: 7098 (P-1)
6	HV Test at Room Temp	IS: 7098 (P-1)
7	Test on Armour Wire/ Strip	IS: 3975
8	Flammability Test	IS: 7098 (P-1)
9	Anti Termite & Rodent Test	As per standards
10	FRLSH Properties (For FRLSH PVC Only)	
i	Oxygen Index	ASTM D 2863
ii	Temperature Index	ASTM D 2863
iii	Smoke Density Rating	ASTM D 2843
iv	Acid Gas Generation	IEC-754-1
v	Flammabilty Test	IEC-332-1
vi	Swedish Chimney test	SS-424-1475 Class-F3

20.07.00 **SPECIAL TESTS ON PVC 'FR-LS' MATERIAL**

All the sizes of XLPE power cables of the 'FRLSH' PVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LS' type 'PVC' to meet these special tests: -

20.07.01 Oxygen Index Test

The Oxygen index shall not be less than 29 at room temperature.
This test shall be carried out as per American National Std. ASTM-D-2863/ 77.

For determination of the temperature index, the oxygen index test shall be carried out at different temperature up to 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temperature index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

20.07.02 Acid gas emission test on sheath material: -

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.

20.07.03 Smoke density test on sheath material: -

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.

20.07.04 Flammability test on finished cable sample: -

This test shall be carried out as per the following method:

After the test, there should be no visible damages on the test specimen within 300mm from its upper end.

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly.

Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.

IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by Owner.

IEC Std: 332-1. – The cable should meet the requirement of all the above standards.

20.07.05 Temperature Index Test

The measured value of temperature index shall be not less than 250°C.

20.08.00 **ROUTINE TESTS**

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985:-

a) High Voltage Test
b) Conductor Resistance Test
c) Partial discharge test (for screened cables) – on full drum length.

20.09.00 **ACCEPTANCE TEST**

The following test shall be carried out as Acceptance Test in the presence of HPGCL Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost:-

a) High Voltage Test
b) Conductor Resistance Test
c) Tensile / wrapping test.
d) Partial discharge test (In screened cables).
e) Insulation Resistance/Volume resistivity test
f) Measurement of thickness of insulation and sheath and other dimensions
g) Tensile strength & elongation at break for insulation & sheath.
h) Hot set test on XLPE insulation

i) Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
j) Acid gas generation test as per IEC-754-1.
k) Smoke density test as per ASTM-D-2843/1977
l) Oxygen index test as per ASTM-D 2863/1977
m) Temp. index test as per ASTM-2863/77
n) Test for Rodent and termite repulsion property

20.10.00 **TEST WITNESS**

Tests shall be performed in presence of Owner's representative. The Bidder shall give atleast fifteen (15) days advance notice of the date on which the tests are to be carried out.

20.11.00 **TEST CERTIFICATES**

i) Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner's representative.

ii) Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review.

iii) The cables shall be dispatched from works only after receipt of Owner's written approval of the test reports.

20.12.00 **DRAWINGS, DATA AND MANUALS TO BE FURNISHED FOR APPROVAL**

Bidder shall submit the following minimum drawings and documents for approval during detail engineering stage.

- Design basis report
- Cable sizing calculation
- General arrangement drawings
- Technical data sheet
- Test reports
- Catalogues
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

DATA SHEET

LV POWER CABLES 1100V GRADE

1100 V grade, 90ºC continuous rating under normal condition and 250°C short time rating under short circuit condition XLPE insulated FRLSH sheathed heavy duty, power cable conforming to following requirement and in line with IS 7098, IS 8130, IS 5831 and IS 3975.

S. NO.	DESCRIPTION	SPECIFICATION
1	Conductor	Stranded and compacted plain aluminium of grade H2 and class 2/stranded, high conductivity annealed plain copper, generally conforming to IS:8130
2	Insulation	Extruded Cross linked Polyethylene (XLPE).
3	Core Identification	By colour coding
4	Inner Sheath	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831 for multicore cable. Single core power cables need not be provided with any inner sheath.
5	Armour	Galvanised single round/ strip steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 grade for single core cables.
6	Overall Sheath	Extruded FRLSH PVC compound conforming to type ST2 of IS: 5831.
7	Oxygen Index	Minimum 29%
8	Drum	Conforming to IS-10418 (Wooden drum)

1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES

1100V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core / single layer of round galvanized steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 950 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

ANNEXURE – A

PREFERED CABLE SIZES

S. No.	Description of Cable
A	**LV Power Cable**
1.	2C x 2.5 sqmm Cu XLPE Cable
2.	2C x 16 sqmm Al XLPE Cable
3.	2C x 35 sqmm Al XLPE Cable
4.	3C x 2.5 sqmm Cu XLPE Cable
5.	3C x 16 sqmm Al XLPE Cable
6.	3C x 25 sqmm Al XLPE Cable
7.	3C x 35 sqmm Al XLPE Cable
8.	3C x 50 sqmm Al XLPE Cable
9.	3C x 70 sqmm Al XLPE Cable
10.	3C x 95 sqmm Al XLPE Cable
11.	3C x 150 sqmm Al XLPE Cable
12.	3C x 185 sqmm Al XLPE Cable
13.	3C x 240 sqmm Al XLPE Cable
14.	3C x 300 sqmm Al XLPE Cable
15.	3C x 400 sqmm Al XLPE Cable
16.	3.5C x 35 sqmm Al XLPE Cable
17.	3.5C x 70 sqmm Al XLPE Cable
18.	3.5C x 95 sqmm Al XLPE Cable
19.	3.5C x 185 sqmm Al XLPE Cable
20.	3.5C x 240 sqmm Al XLPE Cable
21.	3.5C x 300 sqmm Al XLPE Cable
22.	3.5C x 400 sqmm Al XLPE Cable
23.	4C x 4 sqmm Cu XLPE Cable
24.	4C x 16 sqmm Cu XLPE Cable
25.	1C x 630 sqmm Cu XLPE Cable
B	**Cables for Electronic Earthing**
1.	1C x 35 sqmm Cu XLPE Cable
2.	1C x 150 sqmm Cu XLPE Cable
C	**FS Power Cables**
1.	4C x 4 sqmm Cu FS Cable
2.	2C x 25 sqmm Cu FS Cable
3.	2C x 50 sqmm Cu FS Cable

CHAPTER – 22

CABLING SYSTEM

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CHAPTER – 22

CABLING SYSTEM

22.01.00 **SCOPE OF WORK**

22.01.01 The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling, ~~fire stop mortar seal, fire retardant cable coating system etc~~. the scope shall broadly cover, but not be limited to:

1. COOLING TOWER

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

22.02.00 **SCOPE OF SUPPLY**

22.02.01 The equipment and materials within the scope of supply shall include but not limited to:

i) Power & control cabling works for electrical and I&C (including that of special cables):

ii) Galvanized steel prefabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.

iii) Supply and installation (including laying & termination) of control cables, special cables, I&C cables for all equipment and systems.

iv) FRP trays with fire retardant corrosion resistance properties and its accessories shall be provided in corrosion prone areas such as Battery

Rooms, Chemical handling area, Water treatment area exposed to corrosive atmosphere.

v) Supply and installation (including laying & termination) of all power cables (HV, MV and LV) for all equipment and systems.

vi) Cable routing has to be planned such that it shall not cross the steam lines, oil lines.

vii) Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.

viii) Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fireproof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

ix) Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.

x) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

xi) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the Bidder without any extra charge to the Owner.

xii) Bidder shall arrange all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work.

22.03.00 CODES AND STANDARDS

22.03.01 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.) mentioned in Chapter 37, the stringent shall prevail..

22.03.02 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. shall 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 along with 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.

22.04.00 DESIGN AND CONSTRUCTIONAL FEATURES

22.04.01 Inter Plant Cabling

Interplant cabling for main routes shall be laid along overhead trestles/ pipe racks. However, from tap-offs, same can be through trenches of lengths restricted to 10 metres. Cable trenches are acceptable only in the transformer yard. In case of Duct banks for crossing of railway lines & roads, pull-pits shall

be provided with a PCC covering. Trestles to be provided for routing of cables, pipes etc. shall have a clear height of 8.0m in main plant area, at road/ rail crossings so as to clear the road spaces/ railway lines, approach to maintenance bays of various buildings. A walkway with handrails and toe guards of 600mm (minimum) width shall be provided all along length of the trestle for maintenance of cables and pipes. Ladders for approach to these walkways shall be provided near roads, passageways at suitable locations.

22.04.02 Cable entry

Cable entry from outdoor underground/cable routes to the buildings, if any, shall be above the finished floor level of the building.

22.04.03 Cable Routing

i) PCC flooring of built-up trenches (provided as per (iv)) shall be sloped for effective drainage with sump pits and sump pumps.

ii) No subzero level cable vault/trenches shall be provided below control building/switchgear rooms in the entire power plant. A cable spreader room to be provided below all switchgear room and control rooms in all areas.

iii) All field switches for equipment corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened I&C cables.

iv) Cable trenches shall be provided only in transformer yard and locally near the equipment having length not more than 10 metres. In GIS hall Cable slit/chase shall be provided.

v) Two separate cable routes one on each side shall be provided. Cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mills shall be routed in one route & for through other set of auxiliaries through other route.

vi) Bidder shall provide two independent routes for cables within the Main Plant Building.

vii) Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays in addition to normal tray cable loadings.

viii) Cables for pull cord switches, belt sway switches along the conveyors and receptacles in coal conveyors shall be routed in conduits.

22.04.04 Cable Vault:

i) Cable vault of not less than 3.5 metres clear height shall be provided.

ii) Clear access passage of at least 800 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways. Wherever the

passage is through cable routes clear height shall not be less than 1.5 Mts.

iii) Cable vaults shall be provided with adequate drainage facility for drainage of fire water.

iv) Each cable vault should have two fireproof doors.

v) Exit signs shall be provided near doors for personnel escape in case of emergency.

22.05.00 EQUIPMENT DESCRIPTION

22.05.01 Cable trays, Fittings & Accessories

i) 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 HV, MV & LV power & control cables and perforated type for I&C cables. However, in vertical riser's ladder cable trays shall be used for I&C cables also.

ii) These shall be prefabricated hot dip galvanized sheet steel trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

iii) Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm & 150mm may be used in places considering the requirement and space constraint. The trays shall have standard lengths of 2.5 metre. Minimum 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 minimum 3 mm. Cable tray covers shall be fabricated from 1.6 mm thick MS sheets.

iv) 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 minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

v) Prefabricated hot dip galvanized mild steel cable trays shall be used for maximum support span of 1500 mm. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/75 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

vi) The tolerance for cable trays and accessories shall be as per IS 2012 (Part 1). Tolerance Class – Coarse.

vii) In areas, where acid/alkalie ingration is likely (such as Battery Room, etc.) to occur, Fibre Reinforced Plastic trays with fire retardant corrosion resistance properties shall be used.

viii) Deflection Test

A 2.5-metre straight section of each type of cable trays shall be simply supported at the two ends. A uniformly distributed load of 100Kg per meter shall be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7mm.

22.05.02 **Support System for Cable Trays**

i) Cable tray support system shall be prefabricated similar or equivalent to "Unistrut make".

ii) 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:

a) C1:- having provision of supporting cable trays on one side and
b) C2:-having provision of supporting cable trays on both sides.

iii) 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 hardware 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, hardware's fittings and accessories shall be prefabricated factory galvanised.

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 galvanized 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 galvanized after completing welding, cutting, drilling and other machining operation.

e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 mm thick rolled steel sheets conforming to IS.

f. Cantilever arms of 170mm , 320mm, 470mm and 620mm in length are required for 150mm, 300mm, 450mm and 600mm wide cable trays respectively. 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. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover

installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

h. The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above 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. The Bidder shall submit the detailed drawings of the system offered by him along with the bid.

22.05.03 **Pipes, Fittings & Accessories**

i) 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

ii) GI Pipes shall be of medium duty as per IS: 1239.

iii) 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.

iv) Hume pipes shall be NP3 type as per IS 458.

v) HDPE pipe and conduits shall be PE-80, PN-10 type as per IS 4984/IS 8008 part-I.

vi) TERNE Coated Flexible Steel Conduits shall be waterproof 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.

22.05.04 **Junction Boxes**

i) Junction boxes shall be of 16 SWG sheet steel hot-dips galvanized, out-door type, dust vermin and damp proof, generally conforming to IP 55.

ii) Junction box surface should be such that it is free from crazing, blisters, 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 EN 50102.
b. Thermal ageing at 70deg C for 96 hours as per IEC60068-2-2Bb.
c. HV test

iii) Junction boxes shall be complete with neoprene gasketed inspection cover, conduit knock out, terminal blocks and painted with one coat of red oxide primer and two finishing coats of synthetic enamel paint shade as mentioned in Chapter 1.

iv) Junction boxes for outdoor use shall be weatherproof IP-55 and those for hazardous location shall be flame-proof type. Outdoor junction boxes shall be epoxy painted.

v) Junction boxes shall be of two types viz one suitable for control wiring and the other with terminals for power cable terminations. Junction boxes for power cable terminations shall have minimum nine (9) nos. of terminals. Size of terminals shall be suitable to accommodate cables of sizes as required.

vi) The junction boxes shall have the following indelible markings:-

a) Circuit nos. on top by white-stenciled paint at site.
b) Circuit nos. with ferrules (inside) as per approved drawing.
c) Danger sign in case of 415 V circuit.
d) Junction boxes shall be provided with two Nos. (2) earthing terminals complete with nuts and washers suitable for connection to 8 SWG G.I. wire.

22.05.05 **Terminals**

Multi-way terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

i) Each control cable terminal shall be suitable for connection of 2 Nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

22.05.06 **Terminations & Straight Through Joints**

i) Termination and jointing kits for 11/6.6 kV grade XLPE insulated cables shall be of proven design. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/6.6 kV grade joints and terminations shall be type tested as per IS: 13573/ IEC 60502. Test reports shall be furnished. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. The kit shall be complete with the copper solder less crimping type cable lugs & ferrule as per DIN standard.

ii) Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 6.6 kV systems.

iii) 1.1 KV grade straight through joints shall be of proven design.

22.05.07 **Cable Glands**

i) Cable glands shall conform to BS: 6121 and 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 microns. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful Bidder.

ii) Cable glands shall be double compression type. Glands for classified hazardous areas shall be double compression type flameproof and weatherproof duly certified by CMRS and approved by CCE. Cable glands shall match with the sizes of different HT/LT/Control cables.

22.05.08 **Cable Lugs/Ferrules**

i) The cables lugs shall be conforming to IS: 8309.

ii) Machine ferruling shall be adopted.

iii) Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

iv) The cable lugs for control/I&C/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.

v) Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types: -

- Copper tubular terminal end for solder less crimping to copper conductors.
- Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan.
- Pin type lugs shall not be used.
- Aluminium tubular terminal ends for solder less crimping of two Aluminium conductor.
- Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/I&C cables shall be PVC insulated/sleeved type.

22.05.09 **Cable Clamps & Straps**

i) The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

ii) 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 to withstand the forces generated by the system short circuit current of 105 KA peak.

22.05.10 **Galvanizing**

i) Galvanizing of steel components and accessories shall conform to IS: 2629, IS 4759 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots.

ii) 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.

22.05.11 **Welding**

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.

22.06.00 CONSUMABLES AND HARDWARE

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

22.06.02 The materials shall include but not limited to the following:-

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

ii) Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

iii) Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

22.07.00 METHODS AND WORKMANSHIP

22.07.01 All work shall be installed in a first class, neat workman like manner by mechanics/electricians skilled in the trade involved.

22.07.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.

22.07.03 All details on installation shall be electrically and mechanically correct.

22.07.04 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

22.08.00 INSTALLATION

22.08.01 Installation work shall be carried out in accordance with good engineering Practices.

22.08.02 Prefabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces shall be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

22.08.03 Cable trays inside buildings shall be aligned and leveled properly. All tray runs shall be installed parallel to the building walls.

22.08.04 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

22.08.05 The cable trays shall be supported in general at a span of not exceeding 1.5 metres horizontally and 1.0 metre vertically.

22.08.06 Sufficient spacing not less than 300 mm (Between bottom of the upper tray and top of the lower tray) shall be provided between trays and maintained to permit adequate access, for installing and maintaining the cables.

22.08.07 Cable trays in areas subject to oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.

22.08.08 Cable tray/conduit system shall be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.

22.08.09 Different voltage grade cables shall be laid in separate trays when trays are run in tier formation. Power cables shall normally be on top trays and control/I&C cable on bottom trays.

22.08.10 All cable way sections shall have identification, designations as per approved cable way layout as 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 meters. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

22.08.11 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. In such cases the Bidder shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining Owners prior approval, which 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.

22.09.00 CONDUITS/PIPES/DUCTS INSTALLATION

22.09.01 The Bidder shall be fully responsible 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 waterproof by the Bidder.

22.09.02 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.

22.09.03 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.

22.09.04 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 deg to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for

ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

22.09.05 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
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm or above	3.0 M

22.09.06 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

22.09.07 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Bidder), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Bidder. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the Bidder at no extra cost.

22.09.08 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.

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

22.10.00 JUNCTION BOXES INSTALLATION

22.10.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner 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.

22.11.00 CABLE LAYING AND INSTALLATION

22.11.01 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays and aligning and leveling as required shall be the responsibility of the Bidder.

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

22.11.03 **Laying of cables directly buried in ground is not acceptable**

22.11.04 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The Bidder shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the Bidder. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

22.11.05 While laying cable, ground rollers shall be used at every 2 metre 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.

22.11.06 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

22.11.07 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they shall not be subjected to heat from adjacent hot piping or vessels.

22.12.00 LAYING OF CABLES IN CABLE TRAYS

22.12.01 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, Bidder shall route these as directed by the Owner.

22.12.02 Power and control cables shall be laid on separate tiers. 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.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. 11 kV/ 6.6 kV/ 1.1 kV Single core power cable shall be laid in trefoil formation with 2D gap where D is the diameter of the cable and clamped at every two

metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and I&C cables can be laid upto a maximum of three layers in each tray.

22.12.03 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/tray with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles.

22.12.04 Power and control cables shall be secured fixed to trays/support with self-locking type nylon cable straps with de-interlocking facilities. 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 by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five-meter interval and at every bend.

22.12.05 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

22.12.06 Individual cables or small groups which run along structures/walls etc shall be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100.They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure shall result.

22.12.07 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.

22.12.08 Where cables cross rail tracks/roads, the cables shall be laid in Hume pipe/PVC pipe. The hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.

22.12.09 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of Owner.

22.12.10 **Cable joints are not preferred. Joints shall be allowed as a special case only when the length of the run, in case of single core 11kV UE/ single core 6.6kV UE/single core LT Power Cable/Control Cable exceeds 1000 metres or 750 metres in case multicore of 11kV UE/6.6kV UE power cables.**

22.12.11 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV 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.

22.12.12 Wherever few cables are branching out from main trunk route troughs shall be used.

22.12.13 Cables shall be neatly arranged in the trenches/trays in such a manner so that crisscrossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Bidder.

22.12.14 The Bidder shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical Bidder and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the Bidder. During the erection period the Bidder shall furnish a monthly report on cable position in an approved proforma so as to keep the Owner appraised of the position.

22.12.15 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. Bidder 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.

22.12.16 Electrical cable trays exposed to hazardous process fluid or near oil exposed areas shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

22.12.17 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

22.12.18 Separation

i) Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.

i) At least 300mm clearance shall be provided between:
- HV power & LV power cables,
- LV power & LV control/I&C cables,

22.12.19 Segregation

i) Segregation means physical isolation to prevent fire jumping.

ii) Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

iii) 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.

iv) In the existing 220kV AIS for the ICT bays control cables of each bay shall be laid on separate cable trays.

22.12.20 Wind loading shall be considered for designing support as well Cable trays wherever required.

22.12.21 Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.

22.13.00 CABLE FIRE SEALING

22.13.01

22.13.02

22.13.03

22.14.00 Cable laying in trenches

22.14.01 RCC cable trenches with removable covers shall be provided by the Bidder. Cables shall be laid in 3 or 4 tires in these trenches. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the Bidder at no extra cost.

22.14.02 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

22.14.03 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover tilt such times the final termination to the equipment is completed.

22.14.04 Prior to laying of cables inside both indoor and outdoor trenches, the Bidder shall properly clean inside of those trenches.

22.14.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer.

22.14.06 Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

22.14.07 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.

22.14.08 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.

22.14.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit, the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

22.14.10 Following guide of the pipe fill shall be used for sizing the pipe size:-

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 51% full
c) 3 or more cables - 40% full

22.14.11 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively, G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

22.14.12 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings shall be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical Bidder shall determine their location and obtain approval of the Site Engineer before cutting is done.

22.15.00 CABLE IDENTIFICATION

22.15.01 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 & exit, 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 Bidder may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

22.15.02 If laying of underground cable is specifically agreed by Owner **as a special case,** then the underground cables shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable

trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription `Cable Joint'. For buried cables the marker shall project 150mm above ground.

22.15.03 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

22.16.00 CABLE TERMINATIONS & CONNECTIONS

22.16.01 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer'' instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Bidder shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

22.16.02 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 Site Engineer.

22.16.03 Responsibility of proper termination shall lie on the Bidder. Guarantee for termination shall also have to be given by the Bidder.

22.16.04 The equipment shall be generally provided with undrilled gland plates for cables/conduit entry. The Bidder 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.

22.16.05 Bidder shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the Bidder at the discretion of the Engineer- in-Charge.

22.16.06 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.

22.16.07 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.

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

22.16.09 It is the responsibility of the Bidder to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

22.16.10 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

22.16.11 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.

22.16.12 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

22.16.13 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Bidders shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

22.16.14 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.

22.16.15 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

22.16.16 In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

22.16.17 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

22.16.18 Crimping shall be done by hand crimping/hydraulically operated tool and conducting jelly shall be applied on the conductor.

22.16.19 Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

22.16.20 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

22.16.21 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least two (2) hours.

22.17.00 Cable accessories for H.V. Systems

22.17.01 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

22.17.02 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the Bidder or the type of cables issued by Owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include connecting ferrules/thimbles all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.

22.17.03 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a) 'PUSH ON' type for LV cables. 'TAPEX' of M-seal make or equivalent for LV cables.

b) Heat-shrinkable sleeve type for MV & HV cables.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

22.17.04 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types:-

a) TAPEX' of M-seal make or equivalent for LV cables
b) Heat-shrinkable sleeve type for MV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of Owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

22.18.00 CLEANING UP OF WORK SITE

22.18.01 The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or driveways.

22.18.02 Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

22.19.00 QUALITY ASSURANCE PROGRAMME

22.19.01 Bidder shall furnish detailed Quality Assurance Program and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

22.20.00 TESTS

22.20.01 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

Routine Tests

- Routine tests as per specification and applicable standards shall be carried out on all requirements/items covered in the specification.
- Physical & dimensional check on all equipments as per approved drawings/standards .
- HV/IR as applicable.
- Check/ measurement of thickness of paint/zinc coating/nickel-chrome plating as per specification & applicable standard.

Acceptance Test

- Galvanising Tests as per applicable standards
- Welding checks
- Deflection tests on cable trays as per procedure given in 22.05.01 (viii).
- Proof load tests on cable tray support system as per standards.

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

Galvanizing Tests

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

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

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

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

22.21.00 WELDING

22.21.01 The quality of welding shall be visually inspected, particular attention being paid to the following points:-

i) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

ii) The weld metal shall be properly fused with the parent metal without undercutting.

iii) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

22.22.00 COMMISSIONING

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

Cables

a. Check for physical damage
b. Check for insulation resistance before and after termination/jointing.
c. HT cables shall be pressure tested (test voltage as per IS:7098) before commissioning.
d. Check of continuity of all cores of the cables.
e. 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 bidder.
f. Check for correct polarity and phasing of cable connections.
g. Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.
h. Check for provision of correct cable tags, core ferrules, tightness of connections.

CABLE TRAYS / SUPPORTS AND ACCESSORIES

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

CHAPTER – 26

EARTHING & LIGHTNING PROTECTION

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CHAPTER – 26

EARTHING & LIGHTNING PROTECTION

26.01.00 GENERAL

This specification is intended to cover the design, engineering, manufacture, assembly, testing at manufacturer's works, supply in properly packed condition for transport to site and delivery Grounding and Lightning system complete with all accessories for efficient and trouble-free operation.

26.02.00 CODES AND STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC as mentioned in Chapter 37 except where modified and/or supplemented by this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments. All work shall be carried out as per applicable codes and standards.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, VDE etc. shall 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 along with copies of all official amendments.

26.03.00 GROUNDING & LIGHTNING PROTECTION

26.03.01 General

The main objectives of grounding system are to:

a) Provide safety to personnel from contact of dangerous potential caused by ground fault.
b) Ensure sufficient grounding current for effective relaying.
c) Stabilize circuit potential with respect to ground.
d) Bidder shall carry out earth resistivity test of power project site within battery limit and shall establish homogeneous soil resistivity for earthing design. Number of earth resistivity test locations shall be not less than 15. The test locations shall be subject to Owner’s approval.
e) Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.
f) Bidder to submit the earthing layout drawings including earth mat, lightning protection layout drawing, detailed design and calculations, etc., for Owner’s approval.

26.03.02 Grounding system

i) In order to meet the above objectives, symmetrical ground grid mesh shall be provided for the entire area within battery limit.

ii) Fault current for the earthing system shall be designed for 63 KA for duration of 1 sec in GIS and 50 kA for duration of 1 sec in other areas.

iii) All electrical equipment, non-current carrying metal parts, structures, building steel, lightning protection system, transformer neutrals shall be connected to this station ground grid.

iv) Treated earth pits including riser shall be provided for Transformer neutral earthing.

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

vi) Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

26.03.03 **Ground Grid Conductor**

i) Ground grid conductor of mild steel rod shall be used.

ii) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the steel corrosion (by soil) loss of 0.12 mm (on diameter of conductor) per year over the design life of 40 years.

26.03.04 **Underground Grid**

i) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE 665 and touch voltage & step voltage is to be calculated considering weight of person 50 Kg.

ii) The ground grid conductors shall be buried in earth at a depth of 600 mm. However suitable precaution to be taken wherever underground drains / Trenches are passing through it. The length of ground conductors below earth shall be sufficient to ensure a ground resistance less than one (1) ohm for each area/building. For electronic earthing system shall be less than 0.5 ohms.

iii) The ground grid conductor shall be so laid as to provide short and direct connection to building steel and major electrical equipment.

iv) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.

v) All ground grid conductor connections shall be welded type.

vi) Earth mat of each area/building (ie Main Plant Building, Transformer Yard, Service Building, DG Building and CPU Regeneration building etc.,) shall be interconnected with the earth mat conductor of the neighboring area at least two (2) points for further reducing the ground grid resistance.

vii) A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

viii) In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the

grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

ix) Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.

x) Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

xi) The Bidder shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc.

26.03.05 **Ground Electrode**

Ground electrodes shall be 40 mm dia. and 3-metre-long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductors. All connections to the conductors shall be done by arc welding process.

26.03.06 **Above Ground Connections**

i) Galvanised steel flats shall be used for all connections above earth.

ii) Inside building, ground conductors shall be run for each floor supported on building steel and/or cable trays. These ground conductors in turn shall be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.

iii) Two separate and distinct ground connections shall be provided for each electrical equipment in compliance with I.E. Rules.

iv) All connections above ground shall be welded type except connection to equipment/structures which shall be 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.

26.03.07 **Column Grounding**

All steel columns and structures shall be connected to the earth mat through 40 mm dia M.S. rods. All welded joints shall be painted to protect from rusting.

26.03.08 **Risers**

Risers are required for connecting the equipment and structures with the ground mat. Risers are to be provided from underground mat to above ground levels where the ends shall be left free for connecting to the equipment. Each riser shall be 40 mm dia. M.S. rod and shall project above grade level/concrete floor level by minimum 300 mm. They are to be clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding. Number of risers shall be as per system requirement.

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. Separate dedicated riser shall be provided for C&I earthing purpose and also for Lightning down conductor connection purpose.

26.03.09 **Equipment Ground Lead**

i) Equipment ground connections shall be sized to carry the ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

ii) The minimum ground conductor sizes for various equipment and structures are given in below.

DESCRIPTION	**SIZE**	**MATERIAL**
a) Main Grounding Grid Conductor	40 mm dia Rod	Mild Steel
b) Riser/Pigtail From Grounding Grid/Mat	40 mm dia Rod	Mild Steel
c) Electrode	40 mm dia,3000 mm long Rod	Mild Steel
Conductor used for connection of various equipment/structures as listed below		
i) TGs, GTs, UATs and IPBD	75 x 10 mm	GI Flat
ii) Transformer body	75x10 mm	GI flat
iii) 11 kV &6.6 kV Switchgears, Motors	75 x 10 mm	GI Flat
iv) 415V Switchgear, MCCs, Battery Charger, distribution Boards	75 x 10 mm	GI Flat
v) Sub-mat	75 x 10 mm	GI Flat
v) Segregated and Non segregated Phase Busduct	75 x 10 mm	GI Flat
vi) Gen VT panel	75 x 10 mm	GI Flat
vi) 415 Motors		
1) Above 100 KW upto200 KW	75x10 mm	GI Flat
2) Above 55 KW up to 100 KW	40x6 mm	GI Flat
3) Above 22 KW up to 55 KW	40x6 mm	GI Flat
4) Above 5.5 KW up to 22 KW	25 x 6 mm	GI Flat
5) Up to 5.5 KW	4 SWG	GI Wire

DESCRIPTION	SIZE	MATERIAL
vii) Cable Trays	40 x 6 mm	GI Flat
viii) Control Panel & Control Desks etc.	40 x 6 mm	GI Flat
ix) Steel Column	75 x 10 mm	GI Flat
x) Fence and Gate	40 x 6 mm	GI Flat
xi) Push Button Stations	8 SWG	GI Wire
xii) Lighting panel, Junction Boxes	4 SWG	GI Wire
xiii) System neutrals (for service transformers)	1Cx400 sq.mm	XLPE cable
xiv) Lighting Fixtures & Receptacles	14 SWG	GI Wire
xv) Welding Outlets	8 SWG	GI Wire
xvi) Rails	40 x 6 mm	GI Flat

iii) 75 x 10 mm galvanized steel flats(minimum size) shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing. These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground. Earthing conductors along their run-on column, wall etc. shall be supported by suitable welding/clamping at intervals not exceeding 750 mm.

iv) Earthing conductors can be embedded in concrete floor of the building wherever necessary without having direct contact with the reinforcement rods. At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves. Earthing conductor embedded in the concrete floor of the building shall have approximately 50mm concrete cover.

v) All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.

vi) Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.

vii) Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.

viii) A continuous 40 x 6 mm (minimum size) G.S. flat earthing conductor shall run along the cable trays and supporting structure of all cable routes. This earthing conductor shall be attached to each section of cable tray/trays through 40 x 6 mm G.S. flats. The earthing conductor shall be securely connected to the earth mat at both ends. The distance between earthing points shall not exceed 30 metres.

ix) Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.

x) The street lighting poles, junction boxes mounted on the poles, flood light supporting structures etc. shall be connected to ground grid at minimum two points.

xi) The steel columns, metallic stairs, handrail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.

xii) The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.

xiii) The overhead crane rails shall be grounded at both ends. In addition, all joints shall be bonded to provide electrical continuity.

xiv) The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

xv) The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

26.03.10 **Jointing and Connection**

i) All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

ii) The bending of the large diameter ground conductor where necessary shall be done by gas heating.

iii) The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

iv) The connections between the riser/pigtail and earthing conductors (galvanized steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

v) The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.

vi) The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GS bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

vii) Equipment/structures ground connections shall be coated with weather resistant paints/cold galvanizing paints after proper checking / testing.

viii) Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

26.04.00 **EARTHING OF CABLING SYSTEM**

- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
- Armour of other cables shall be earthed at both ends of cable.
- Screen of HT power cables shall be earthed at one end only.
- Screen of C&I screened control cables shall be earthed at one end.
- Screen of electronic earthing system cables shall be earthed as per the requirements.

After completion of grounding system installation, the measurement of ground resistance shall be performed by the Bidder. continuity of earth conductors and efficiency of all bonds and joints shall be checked. The method of measurement shall be as per relevant standards / codes. The ground resistance of system shall be not more than the values mentioned in Cl 26.03.04 (ii). Earth resistance at earth terminations shall be measured in presence of Owner's representatives

26.05.00 **GENERAL**

i) Electronic earthing shall be provided as per relevant international standard for all control systems (such as DDCMIS, PLC , SAS, EDMS etc.,) For electronic equipment chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 4000 mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be of copper

ii) Neutral of Service transformers shall be earthed through minimum of 400 sq mm single core cable through two numbers treated earth pit and in turn shall be connected to station earth grid.

iii) LV Neutral Points of the following transformers shall be connected to Neutral Grounding Resistors (NGRs). NGR shall be connected to earth through two numbers treated earth pit.

- Unit transformer
- Station Transformer
- Unit auxiliary transformer
- Station auxiliary transformer
- Other auxiliary transformers

iv) Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

v) Earthing conductors along their run-on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals not exceeding 750 mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

vi) Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.

vii) Electronic panels and equipment shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrode.

26.06.00 **EARTHING OF CHIMNEY**

26.06.01

26.06.02

26.06.03

26.06.04

26.06.05

26.07.00 **LIGHTNING PROTECTION SYSTEM**

i) The main purposes of lightning protection system are to:

a) Provide protection to structures from lightning strokes.

b) Provide a low resistance-conducting path to lightning discharge.

ii) Lightning protection shall be provided as per IS: 2309/ IEC 62305/ latest IS Standards for the structures, equipment and buildings.

26.07.01 **System Design**

i) Air termination network with down conductors and earthing electrodes shall be provided on the basis of IS Code of Practice.

ii) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.

iii) Down conductors shall run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.

iv) An earth electrode shall be provided at the connection point of the down conductor with the station ground.

v) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.

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

vii) Galvanised steel rods and flats shall be generally used for air termination and connections. All connections shall be welded type.

viii) The lightning protection system in the transformer yard /AIS shall cover the following equipment in the protection zone.
- Generator transformers
- Station transformers
- Auxiliary transformers
- ICT
- Main Bus I
- Main Bus II

ix) Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.

x) For Lightning protection, material Thickness of galvanising shall be at least 610 gm/sq.m for all Galvanised steel conductors.

xi) The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical

equipment, underground metallic ducts etc. All metallic structures within vicinity shall be bonded to the lightning protection system.

xii) All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.

xiii) Lightning conductor on roof shall be cleated on surface of roof using insulated clamps/saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run.

26.07.02 **Air Terminations**

i) The vertical air terminal rods shall be installed at the roof of buildings for MCC/Switchgear rooms, ESP Control rooms etc to protect these objects from lightning strokes.

ii) The projected length of the Air termination rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

iii) The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

iv) All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 25 x 6 mm galvanized steel flats. Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rod shall be more than nine (9) metres from the nearest roof conductor.

26.07.03 **Shielding Masts**

i) The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of the associated building.

ii) The shielding mast shall be made of galvanized steel rod and the height of the same shall be decided considering the zones to be protected.

iii) Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm minimum. Galvanised steel flat run along the building column. In addition, all building columns joints shall be electrically bonded.

26.07.04 **Down Conductors**

i) Galvanized steel down conductors of suitable size shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.

ii) Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

iii) At all supports for down conductor along the column/wall of the buildings etc. the portion embedded inside the building concrete should not touch the reinforcement bars.

iv) All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

v) The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

26.07.05 **Electrodes (for Lightning Protection)**

i) The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.

ii) All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which shall be laid underground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

26.07.06 **Riser (for Lightning Protection)**

All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

26.07.07 **Jointing & Connection**

i) All ground conductor connections below ground level shall be done by electric are welding with low hydrogen content electrode.

ii) The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

iii) The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

iv) All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

v) The portion of galvanized steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanizing anti-corrosive paint after welding.

vi) The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

vii) The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

viii) The steel to copper connection shall be brazed type.

ix) The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air

terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

x) The sizes and materials of earthing conductors to be used in lightning protection system are listed below:-

DESCRIPTION	SIZE	MATERIAL
1) Horizontal air termination and down conductors for buildings, boilers and other tall structures except Chimney & NDCT.	25 x 6 mm	GI Flat
2) Vertical air termination rods for other buildings / tanks etc except Chimney.	20 mm dia 1000 mm long	MS rod

Note: The above sizes are indicative only. Actual size shall be arrived at as per design by the Bidder.

26.07.08 **Lightning Protection of Chimney**

26.07.09 **Lightning Protection of NDCT**

Pointed vertical air terminal rods shall be provided at the top and these shall be spaced around the circumference of the top. Air terminals shall consist of galvanized steel conductors, each not less than 20 mm diameter, projecting not less than 750 mm above the highest part structure. Air terminals shall be mechanically and electrically connected to a continuous circumferential conductor. Number of down conductors as per IS: 62305, shall be located along the exterior wall (equally spaced), shall extend to the base to earth electrode pit, and shall be connected to the power station earth grid.

The Bidder shall provide and maintain a temporary lightning protection system until permanent lightning protection system is installed.

26.08.00 **TESTS**

26.08.01 Routine Tests

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

Physical & dimensional check on all equipment as per approved drawings/ standards.

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

26.08.02 Acceptance Test

Galvanising check as per applicable standards.

26.09.00 **COMMISSIONING**

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

Earthing continuity checks.

Earthing resistance of the complete system as well as sub system.

CHAPTER – 25

ILLUMINATION SYSTEM

25.01.00 SCOPE OF WORK

This scope of work shall cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport F.O.R. site of Lighting System, complete with all materials and accessories for efficient and trouble-free operation.

The scope of work shall also include design, engineering installation, testing, commissioning and putting into successful commercial operation of the lighting system supplies.

25.02.00 SCOPE OF SUPPLY

25.02.01 The equipment and materials within the scope of supply shall include but not limited to:

i. Lighting transformer.

Chip efficacy shall be minimum 120 lumen / watt.
Luminaire efficacy shall not be less than 100 lumen / watt in line with clause 25.09.04 of Chapter 25, Vol-IV.

ii. BEE 5 Star rated LED lights (minimum 120 lumens per watt) .

iii. Lighting panels/boards: Main lighting distribution boards, emergency lighting distribution boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with Energy Saving System.

Energy saving system is not required for lighting panels.

iv. Street lighting poles, flood lighting towers and high masts.

v. Ceiling fans, pedestal fans, receptacles, switches, switchboards, portable emergency lighting unit, portable 24V supply module including handset maintenance equipment etc.

vi. Cables, wires, splicing/termination kits/connection accessories.

vii. Conduit and accessories, junction and pull boxes, terminal blocks.

viii. Grounding materials and connections.

ix. All fittings, supports, brackets, anchors, clamps and connections.

x. Steel for field fabrication of supports and brackets.

25.03.00 SCOPE OF SERVICE

25.03.01 Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the Energy Saving System.

25.03.02 Furnishing of all labour (skilled and unskilled), supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware and transport for timely and efficient execution of the contract work.

25.03.03 Preparation of AS-BUILT drawings showing field modifications, if any.

25.03.04 Areas to be covered in BTG package are Turbine generator building (all elevations), Transformer yard, Boiler area including various platforms, coal mill premises including bunker floor & mill maintenance, ESP area including ESP control room, switchgear /MCC rooms, Fuel oil Pressurization pump house, package Boiler building, cable gallery, Service building, DG building, CPU regeneration building, AC equipment & gas room, condensate storage tank & hot well make up and boiler fill pumps area, all roads within battery limit and area illumination of the above premises.

25.03.05 Any other area/premises not specifically mentioned here, but which fall under the battery limit of this package are included in the scope.

25.04.00 **CODES AND STANDARDS**

25.04.01 The design, manufacture and testing of equipment shall be carried out as per the latest Indian/International Standards, Indian Electricity Rules, Relevant Code of Practices and requirements of Govt. of Haryana.

25.04.02 All standards and codes of practice mentioned in Chapter 37 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 stringent shall prevail. All work shall be carried out as per codes and standards mentioned in Chapter 37.

25.05.00 **DESIGN CRITERIA**

25.05.01 The system provides lighting and electric power supply to all areas of the Power Plant. In addition, it also provides lighting to selected areas during plant emergency conditions.

25.05.02 The system shall be installed in an adverse industrial environment. Equipment in some areas shall be subject to vibration, coaldust and oil / water vapours as prevalent in a thermal power generating plant.

25.05.03 The design shall be such as to provide minimum lighting levels & lighting fixtures for different areas as per Annexure.

25.05.04 The illumination system shall be designed based on 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.

25.05.05 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.

25.05.06 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.

25.05.07 Bidder 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.

25.06.00 **SYSTEM CONCEPT**

The lighting system shall comprise of following sub-systems: -

25.06.01 Normal A.C. Lighting

i) This shall be provided by A.C. lighting fixtures distributed throughout the plant. These lights shall be ON as long as the A.C. supply is available.

ii) A.C. lighting fixtures shall be fed from respective area lighting panels, which in turn shall be connected to main lighting distribution board (MLDB). The main lighting distribution boards shall be fed through respective lighting transformer (415V /415V) which forms a part of the MLDB. Normal A.C. supply thus made available for the Normal lighting system is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20% spare outlets.

25.06.02 Normal cum Emergency A.C. Lighting

i) Emergency A.C. lighting shall be provided in Main Plant Building (all elevations), boiler area, boiler galleries, Service Building, DG Building, Transformer yard, ESP Area, ESP control room, CPU Regeneration Area, Fuel Oil Pressurization Pump House, FGD Area and 400 kV Switchyard Control Room for general visibility, safe movements and operation of important auxiliaries.

ii) The emergency LDBs (ELDB) are similar to the MLDB except that lighting transformers (415V/415V) in this case are fed from Emergency Services PMCC bus having D.G. System backup. Thus, power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.

iii) The lighting fixtures connected to this system shall be available whenever normal supply is available in the plant and also when DG set supplies power to 415V A.C emergency bus.

iv) At least 20% of the fixtures shall be fed from AC emergency source.

25.06.03 Emergency D.C. Lighting

i) This will be provided by D.C. lighting fixtures located strategically in critical operating areas and emergency exits. Emergency D.C. lighting fixtures will be fed from respective area DC lighting panels (DCLP) either through cable junction box or direct, which in turn will be connected to DC Emergency Lighting Distribution Board (DCELDB).

ii) These lights shall be normally OFF. In case of failure of AC system, these lights shall be energized from the DC supply through automatic switching. The DC supply will be automatically switched OFF after about 3 minutes following the restoration of supply AC supply. LED suitable for 220 V DC operation may be used for DC emergency lighting.

iii) Lighted Exit signs shall be provided and installed in the control room, switchgear room, relay room, maintenance areas.

iv) In auxiliary/off site buildings except CHP emergency DC lighting is to be provided using 'Instalite' type fixtures which is permanently connected to normal supply charging a battery having four (4) hours back up. These shall switch "ON" automatically when AC power supply goes "OFF".

v) For CHP 18W LED DC lighting fixture shall be provided in underground portion of the conveyor, each switchgear room, control room, office room and pump houses.

25.06.04 Street/Area Lighting

Time switch and photocell shall be used for controlling streetlights with provision for manual override.

Illumination to the roads shall be provided by providing street lighting poles.

25.07.00 **RATING & REQUIREMENT**

25.07.01 The lighting system shall be supplied from 415 V/415 V ± 10%, indoor, dry type cast resin encapsulated lighting transformers. Rating of each transformer shall be decided to limit the fault level within 10 kA.

25.07.02 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

25.07.03 Switch, miniature circuit breakers (MCB), MCCB, bus bars shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

25.07.04 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

25.07.05 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

25.07.06 Heavy duty XLPE FRLS cables shall be used only for connections:

i. From PCC/PMCC/MCC to Main lighting distribution boards.

ii. From main lighting distribution boards to area lighting panels.

iii. From street/area lighting panel to street light poles/towers

25.07.07 Lighting of all main streets, approach roads to various buildings etc shall be included.

25.07.08 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.

25.08.00 **METHOD OF CALCULATION**

25.08.01 Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.

25.08.02 The coefficient of utilization shall be considered to take care of Lumen loss due to: -

i. Effect of room dimensions
ii. Absorption of light in luminaries
iii. Absorption of light at various room surfaces in ceiling, wall etc.
iv. Floor cavity, ceiling cavity
v. Mounting height

25.08.03 Additionally, a maintenance factor shall also be considered to account for the fall of illumination due to ageing, pollution like dust deposit etc.

Maintenance factors to be considered for various areas shall be as follows: -

	Area	Maintenance factor
i)	Air-conditioned indoor area	0.8
ii)	Non-air-conditioned indoor area	0.7
iii)	Dust prone indoor and outdoor areas	0.6

Apart from maintenance factor given above, Temperature Correction Factor shall be considered in the lighting design for fixtures located in non-air-conditioned areas.

25.08.04 Reflectance Factor

i. Dusty area such as conveyor galleries/tunnels, TPs/ Crusher House etc. = 50% ceiling, 30% wall, 10% floor.

ii. Clear areas such as switchgear room / control room etc. = 70% ceiling, 50% wall, 10% floor.

iii. Working plain = a) At conveyor walkway level. B) At building floor level.

25.08.05 The Voltage drop from main lighting distribution board to any fixture shall not exceed 3%.

25.08.06 Circuit loading of each lighting panel shall be done in such a way that almost balanced loading in all the phases i.e., R, Y and B is achieved.

25.08.07 At least two sub circuits shall be used for illumination of a particular area.

25.08.08 Sub circuit loading of each lighting panel shall be restricted to 2000W or 10 Nos. fixtures whichever is lower.

Sub circuit loading of each lighting panel shall be restricted to 2000 W or 18 (approx) number of fixtures, whichever is lower. Since fixtures used are LED wattage of fixtures is low, 10 no of fixtures per sub-circuit shall lead to non optimisation of circuits.

25.08.09 The working plane shall be considered at 0.85 m from

25.08.10 The value of the ratio of spacing (S) to mounti commensurate with the type of fittings selected, unifor suspension height for suspended fixtures shall not exceed 1 meter.

25.09.00 **SPECIFIC REQUIREMENTS - SUPPLY**

25.09.01 Equipment and Material

i. Equipment and material shall comply with description, rating, type and size as detailed in this Specification, drawings, Datasheet and Annexures.

ii. Equipment and materials furnished shall be complete and operative in all details.

iii. All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment, or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

iv. All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

25.09.02 Lighting Transformers

i. Lighting transformers shall be three phase Delta / star, 415V / 415V Natural air-cooled dry type encapsulated epoxy cast resin insulated, indoor type dusty vermin proof having 415 V/415 V ± 2 x 2.5% with off load tap-changer on primary side. The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding. Rating of each lighting transformer shall be selected to cater to the maximum connected lighting. The casing of the transformer shall be grounded at least at two (2) points. Insulation class shall be 'F' with temperature rise limited to Class B.

ii.	KVA rating	:	100/50 KVA
iii.	Vector Group	:	Dyn11
iv.	Maximum Temperature rise over 50^0 C ambient in winding by resistance	:	90 °C
v.	Neutral	:	Solidly grounded

25.09.03 Fittings and accessories for lighting Transformers

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

i. 150 mm dia winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.

ii. Handling and lifting lugs both for enclosure and core-coil assembly.

iii. Jacking pad for core-coil assembly.

iv. Inspection covers for cable end box.

v. Door handle operated safety limit switch with 1NO + 1NC contact.

vi. Necessary earthing.

vii. Rating and terminal marking plates.

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

ix. If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

25.09.04 Lighting Fixtures

LED Luminaires shall be used for the lighting of all the indoor & outdoor areas in bidder's scope. However for hazardous areas conventional 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.

Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop one connection of PVC wires of following sizes: -

a) Lighting fixture: 2.5 Sq.mm Copper
b) Flood Light fixture: 2x2.5 Sq.mm Copper

25.09.05 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

25.09.07 Lighting Panel/Distribution Boards

i. Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated, fixed type from CRCA sheet steel minimum 2.5 mm thick for load bearing members and 2.0mm for non-load bearing members, suitable for either wall/column mounting on brackets or floor mounting on channel sills. The panel shall be provided with lifting hooks. The LPs shall be connected to LDB only.

ii. Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-54 or better. Outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle housing transformer shall be minimum IP-42.

iii. Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements. The LDB shall be fixed on a bottom channel 75mm.

iv. Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminum cable lugs are to be furnished.

v. The incoming to each Normal and Emergency AC Lighting Panel shall be provided with a triple pole MCB with neutral isolating facility and one earth leakage circuit breaker. Combined type triple pole MCB and earth leakage circuit breaker (ELCB) are also acceptable for incomers to Lighting Panels.

vi. Normal and Emergency AC lighting panels shall have outgoing MCBs having thermal elements for overload protection and an instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 9 kA (minimum) at 230 V AC.

vii. Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.

viii. Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc.

ix. Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on

inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminum with inscriptions indelibly etched on it.

x. Bus bar shall be electrolytic grade hard drawn aluminum, colour coded for easy identification and designed for a maximum temperature of 85 deg C. Minimum size shall be 25 x 6 mm. The current density of aluminum bus bar should not be below 0.8 Amp/Sq.mm. The bus bar shall be provided with heat-shrunk/cold-shrunk PVC sleeve.

xi. Board / Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase bus bars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker is available on the front.

xii. Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

xiii. The incomers of Main and Emergency AC Lighting Distribution Boards (MLDB & ELDB) shall be provided with electronic energy (kWh) meters with suitable communication ports for interfacing with EMS to measure the energy consumed by the lighting loads. The energy meters shall be 3 phase, 4-wire type suitable for measurement of unbalanced loads.

xiv. In lighting and receptacle panel 3-phase and 1-phase MCB should not be mixed.

xv. In high bays, walkway shall be provided for maintaining light fittings. At other places suitable ladder / platform / approach shall be provided for maintaining / replacement of light fittings.

25.09.08 Board/Panel Equipment

i. Each board shall consist of two dry type transformers housed in the different cubicles and a bus coupler. one (1) V.T operated voltmeter with selector switch, one (1) C.T operated ammeter selector switch, VTs, CTs, three (3) Nos. phase energized indication lamps backed up by fuses and incoming triple pole MCCBs. Proper discrimination between outgoing MCCB of lighting distribution board and downstream MCCB of lighting panel shall be ensured.

ii. Each lighting panel shall have an incoming triple pole MCCB with neutral link along with a suitably rated ELCB and a number of outgoing miniature circuit breakers (MCB).

iii. Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.

iv. All MCCB shall be single throw, air break and heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type.

v. Contactors shall be air-break electromagnetic type. Push buttons shall be push to actuate type.

vi. MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

vii. Time switch in street lighting panels shall be photocell type with automatic voltage stabilizer and necessary electronic unit with provision for sensitivity adjustment depending on external light intensity. When the exterior illumination level shall fall below a preset value for a considerable period of time (adjustable 30 sec. to 180 secs.) the electronic unit shall generate signal for the output relay to pick-up and potential-free contact of the same shall be used for control of contactor for lighting system. Sustained normal illumination level being restored (adjustable 30 sec. to 180 sec.) the lights shall switch off.

viii. Voltmeter / Ammeter shall be of accuracy class 2.0 or better as per IS: 1248 Voltmeter / Ammeter selector switch shall be of reputed make.

25.09.09 Receptacles

i. Receptacles shall be heavy duty, complete with individual plug and switch.

ii. The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of 3rd pin.

iii. Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

iv. <u>Chimney</u>

1. 3 Pin Receptacles designed for IP:55 degree of protection shall be provided at every platform level, rated for 20A, 240 V,AC. The Receptacles shall be complete with 20A, 240V, AC switch and 3 pin plug.

2. Heavy duty welding Receptacle rated for 415V, AC, 63A shall be provided at each internal platform level.

25.09.10 Fans & Regulators

i. The fan shall have three well balanced blades. Double ball bearings and shall be reasonably free from noise. Sweep shall be 1200 / 1400 mm Pedestal fans shall also be provided as per Owner's requirement.

ii. Fan motor shall be totally enclosed type with copper winding & class E insulation.

iii. Regulator shall have minimum five steps. Electronic regulator with smooth control is preferred.

25.09.11 Switch & Switch Board

i. All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick Bakelite cover with brass fixing screws.

ii. Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.

iii. Switch boards / boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.

iv. Flush type receptacles where provided shall be so located that only the plug projects outside.

v. Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.

25.09.14 Special Requirement

i. All outdoor illumination fixtures, unless it is fed from photocell/time switch-controlled lighting panel, has to be provided with outdoor type local switches.

ii. In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied the wiring and fixing of the same has to be done by the Bidder.

25.09.15 Conduits and Accessories

i. Conduits shall be rigid steel, hot dip galvanised, furnished in standard length of 3M, threaded at both ends.

ii. Conduits up to and including 25 mm shall be of 14 SWG and conduits above 25 mm shall be of 16 SWG. Minimum size of conduits shall be 20 mm.

iii. Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

iv. Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

25.09.16 Junction Box

i. Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-66.

JB shall be IP-55

ii. Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.

iii. Junction boxes for outdoor use shall weatherproof IPW-66 and those for hazardous location shall be flame-proof type.

iv. Junction boxes shall have following indelible markings:

a) Circuit Nos. on top
b) Circuit Nos. with ferrules (inside) as per drawing
c) DANGER sign in case of 415V circuit

25.09.17 Lighting Cables & Wires

i. Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminum conductor, XLPE insulated, extruded FRLS PVC type ST2 inner sheath, single round G.I. wire armoured and overall FRLS PVC type ST2 sheathed conforming to IS 1554.

ii. Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below:-

RED for R-Phase	BLACK for Neutral
YELLOW for Y-Phase	WHITE for +'Ve D.C.
BLUE for B-Phase	GREY for -'Ve D.C.

From LP to JB main run 2.5 sq.mm Copper wire shall be provided.

iii. Wire size shall be as follows:

For point wiring beyond lighting panel i.e., from lighting Panel to junction box (main run)	:	10 sqmm aluminum. Stranded conductor
From Junction box to lighting fixture	:	2.5 sqmm Copper. Stranded conductor.
Receptacle	:	4 sqmm Copper

25.09.18 Terminals

i. Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

ii. Each terminal shall be suitable for connection up to 2 Nos. 10 Sq.mm stranded aluminum conductors without any damage to the conductor or looseness of connectors.

25.09.19 Portable Emergency Lighting Unit

The portable emergency lighting unit shall be complete with 6 V storage battery (rechargeable), inverter, automatic charger, twin 6W fluorescent tube lamp and test switch. Bidder shall furnish make, type and catalogue. Minimum of 20 Nos. to be supplied.

25.09.20 24V Supply Module

i. Each 24V A.C. supply module shall have one (1) No. air-cooled two winding, 500VA, 1-phase, 50HZ, 240/24V transformer with 6A (240V side) and 16A (24V side) HRC fuse in primary and secondary side and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 16A, 24V AC receptacles located near condenser area shall be wired up to from 24V side of each 24V A.C supply module.

ii. The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.

iii. Minimum 15 Nos. portable 24 V AC Supply modules having sheet steel enclosure with louvers as per above shall be supplied for each unit 24V halogen automobile lamp with reflector along with 1100 V twin core PVC sheathed 2.5 sqmm stranded copper wire of 20 M length as handset.

25.09.21 Nameplate

i) Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions.

ii) All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

25.09.22 Samples

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

25.09.23 Occupancy based Passive Infra-red sensors

The sensors shall be recess mounted, programmable type suitable for lighting load. The detection area shall be minimum 5 metres for standard room height of 3mt. All the calibrated settings shall be stored in non-volatile memory of PIR sensor which shall be unaffected by power supply fluctuations. Necessary 16A contactor shall be supplied along with each sensor & shall be located inside the switch box. Movement based sensors shall be used in common rooms, Staircases, Store Room & Washrooms. Presence based sensors shall be used for Office Cabins, Conference Halls & Meeting Rooms.

25.09.24 Aviation Obstruction Lighting System for Chimney and 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.

Aviation obstruction light unit shall provide easy access to lamp and components.

Four Nos. of obstruction lights shall be installed on outdoor platforms of chimney and at suitable locations on NDCT. The system controller is proposed to be located at 1.2 metre elevation and photo electric controller at about 40 metre elevation. Necessary cables for wiring between photocell & system controller and between system controller & obstacle lights shall be provided

Each item shall be preassembled, routine tested optically and electrically before despatch.

The distance between lighting elevations shall not be more than 105 Metre and lowest lighting elevation shall not be less than 70 metre.

The light unit shall have adjustable bracket with level indicator to ensure accurate vertical placement of the light flash.

High intensity obstacle lights shall meet the following requirements: -

(a) It shall be flashing white light. The effective intensity of obstacle light shall be variable and dependent on background luminance as follows.

S. No.	Background Luminance	Effective Intensity
1.	Above 500 cd/sq m	200000 cd ± 25% cd
2.	50 to 500 cd/ sq m	20000 cd ± 25% cd
3.	Less than 50 cd/ sq m	4000 cd ± 25% cd

(b) The obstacle lights shall flash simultaneously at a rate between 40 to 60 per minute.

(c) The system shall also provide automatic sensing and display of system status and aviation lamp failure detection

Aviation obstruction lighting shall be powered from AC emergency power supply.

Temporary obstruction lighting shall be provided during construction. Obstruction lights shall be provided on the uppermost part of the chimney, or the surrounding scaffolding. As construction progresses each completed level shall be provided with temporary lighting. Temporary obstruction lights shall have four fixtures located in a horizontal plane on the chimney/NDCT structure to ensure unobstructed visibility of at least one obstruction light from aircraft at any normal angle of approach. Power for operation of the temporary obstruction lights shall be obtained from the construction power system.

Supply circuit for these lights shall be furnished, installed and maintained by the Bidder. Temporary obstruction lights shall be operated from sunset to sunrise during each day of the contract period until permanent Aviation Obstruction Warning Lighting (AOWL) are installed.

25.10.00 **SPECIFIC REQUIREMENTS-SERVICES**

25.10.01 Consumables and Hardware

i. The Bidder shall furnish all erection materials, hardware and consumables required for the completed installation.

ii. The materials shall include but not limited to the following: -

a. Consumables	:	Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
b. Hardware	:	Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
c. Materials	:	Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

iii. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Bidder.

25.11.00 **ERECTION TOOLS & TACKLES**

25.11.01 The Bidder shall provide all tools, tackle, implements, scaffoldings, ladders, etc. which are required for handling and erection of the equipment and materials.

25.11.02 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

25.11.03 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

25.11.04 Street Lighting Poles

Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of Bidder.

25.11.05 Flood Lighting Tower

i. Erection of Flood Lighting Towers including civil foundation work shall be done by Bidder.

ii. Bidder shall also mount assembled fixtures; outdoor & lockable type isolating switch cubicle install necessary cabling and wiring make connections.

iii. Floodlights shall be mounted on steel base facing the tentative direction shown on the drawing. Fixing holes shall be provided with slot to turn the fixture about 5° on both sides. Bolts shall be finally tightened with spring washer.

iv. The Bidder shall supply and install the steel base for fixing the flood light on the flood light towers.

v. Terminal connections to the floodlight shall be made through PVC coated flexible metallic conduits.

25.11.06 Receptacles

Receptacles shall be installed at locations shown in the approved drawings.

25.11.07 MLDB, EMLDB, DCLDB and Lighting Panel

MLDB, EMLDB, DCLDB and Lighting Panels shall be erected at the locations indicated in approved drawings.

25.11.08 Lighting High Masts

Erection of Lighting Masts together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of Bidder.

25.11.09 Lighting Fixtures

i. Continuous rows of LED based tube lights shall be mounted on a continuous M.S. angle for each row of lights.

ii. In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.

iii. Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity.

iv. If a roof over platform is available, the fixture can be pendant mounted.

v. The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

25.11.10 Wiring

i. Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

ii. Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.

iii. Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.

iv. For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

v. For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.

vi. A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.

vii. Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

viii. Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

25.12.00 **CONDUIT SYSTEM**

25.12.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.

25.12.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.

25.12.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

25.12.04 Conduits shall be clamped on to approved type space plates or brackets by saddle or U-bolt. The spacer plates or brackets in turn, shall be fixed to the building by welding and to concrete or brick work by grouting as shown on drawing.

25.12.05 Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

25.12.06 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

25.12.07 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.

25.12.08 Where conduits are run on cable trays, they shall be clamped to supporting steel at an interval of 600 mm.

25.12.09 For directly embedding in soil, the conduits shall be coated with an asphalt base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

25.12.10 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

25.12.11 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.

25.12.12 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.

25.12.13 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change shall cause no distortion due to expansion or contraction of conduit run.

25.12.14 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.

25.12.15 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.

25.12.16 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.

25.12.17 Conduit joints and connections shall be made thoroughly watertight and rust proof by application of a thread compound which shall not insulate the joints.

25.12.18 White lead is suitable for application on embedded conduit and red lead for exposed conduit.

25.12.19 The battery Room installation shall be made with acid fume proof conduits.

25.12.20 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.

25.12.21 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

25.12.22 Lighting fixture shall not be suspended directly from junction box in the main conduit run.

25.12.23 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.

25.12.24 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

25.12.25 In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.

25.12.26 Cabling

i. In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the above ground portion.

ii. Buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast concrete stab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.

iii. When buried cables crossroad/railway track, additional protection to be provided in form of G.I. pipe.

25.12.27 Grounding

i. All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.

ii. Ground connections shall be made from nearest available ground grid. All connections to ground grid shall be done by arc welding.

iii. Panels/Boards shall be directly connected to ground grid by two Nos. 35 x 6 mm G.S. flats. (For panels/two Nos. 50x6 mm G.S. flats (for distribution boards).

Lighting Fixture DOP:
Recess Mounting: IP 20;
Indoor: IP 55 &
Outdoor: IP 65

iv. All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 8 SWG G.S. wire.

v. Each street lighting Pole shall be grounded at two points by two Nos. 50x6 mm G.S flat risers from two (2) Nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) Nos. earthing terminals by 16 SWG GS wire. One 16 SWG G.S wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.

Grounding shall be done using 14 SWG GI wire.

vi. Two (2) Nos. earthing spike 3m long & 40 mm dia directly driven into ground at a depth of 1m from ground level shall be provided for each flood lighting tower.

vii. The sheet steel cubicle housing the power supply Isolator at base of flood lighting tower shall be connected at two (2) points from these earthing risers by 16 SWG G.S. wire - The flood lighting fixtures shall be grounded by one (1) 16 SWG G.S wire running through the lighting conduct up to the distribution box.

viii. Two (2) Nos. separate spike of 3m long & 40 mm dia directly driven into ground at a depth of one (1)m from ground level shall be provided for connection of the lighting must on top of flood lighting tower through two (2) Nos. 50x6 mm G.S. flat down conductor.

ix. A continuous ground conductor of 12 SWG G.S. wire shall be run all along each conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.

25.12.28 Foundation & Civil Works

i. Equipment foundations panel foundations and all other civil work shall be provided by the Bidder.

ii. Concrete trenches, cable trays and other civil work shall be provided by the Bidder. The Bidder can make use of those trenches, cable trays etc. for conduit installation.

25.12.29 Excavation and Back Filling

i. The Bidder shall perform all excavation and backfilling as required for buried cable and ground connections.

ii. Excavation shall be performed up to the required depth. Such sheeting and shorting shall be done as may be necessary for protection of the work.

iii. The Bidder shall make use his own arrangements for pumping out any water that may be accumulated in the excavation.

iv. All excavation shall be backfilled to the original level with good consolidation.

25.12.30 Steel Fabrication

i. All supports, hangers & brackets shall be fabricated by the Bidder. Necessary steel shall be supplied by the Bidder.

ii. Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

25.12.31 Painting

i. All steel fabrication shall be given two coats of primer followed by two coats of Siemens gray (RAL-7032) Epoxy Paint.

ii. All equipment shall be given touch-up paint as required after installation.

25.12.32 Cleaning up of Work Site

i. The Bidder shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or driveways.

ii. Upon completion of work, the Bidder shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

25.12.33 Inspection & Testing

i. On completion of erection works, the Bidder shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.

ii. The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Bidder.

iii. The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

iv. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Bidder without any extra cost.

25.13.00 **TESTS**

All tests specified under this clause shall be carried out as per applicable standards.

25.13.01 Type Tests

Type test reports for LED as per standards 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: 16105 report.

25.13.02 Shop Tests

i. All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works and in the presence of Owner’s representatives.

ii. Tests on Lighting Distribution Boards/ Lighting Panels shall include:

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

iii. The tests on LED lights shall include:

a) Colour rendering index (CRI)
b) Colour temperature
c) Light intensity
d) Power consumption
e) Dielectric volatge withstand tests
f) Assembly check
g) THD Test/Harmonics test is done by IS 14700
h) Min Max operating voltage test
i) Lumen test
j) IP Rating Test

25.13.02 Site Tests

i. Bidder shall thoroughly test and insulation resistance test all cables, wires and equipment to prove the same are free from ground and short circuit.

ii. If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

iii. All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

iv. Illumination in different areas is as per designed lux level generally confirming with Indian Standards. The lux level shall be verified by photometer at site location.

25.13.03 Test Certificates:

i. Certified copies of all tests carried out at works and at site shall be furnished in requisite No. of copies for approval of the Owner.

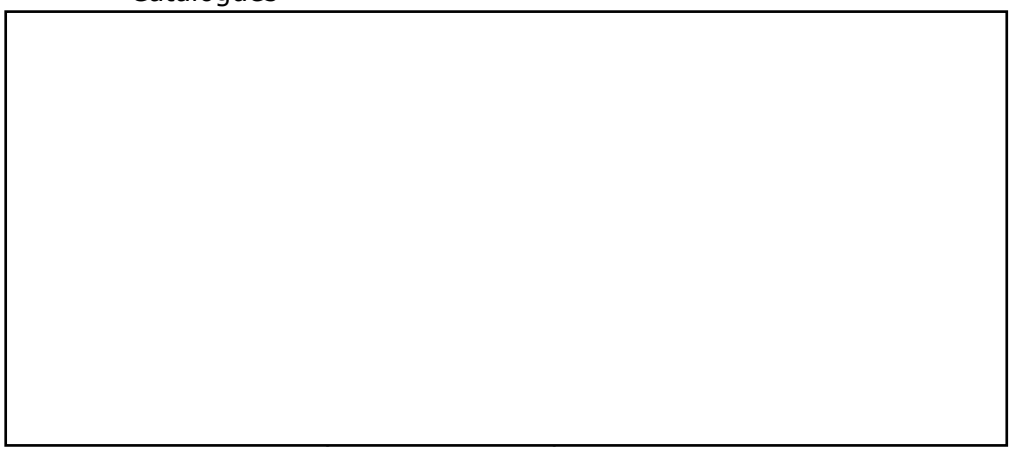
ii. The equipment shall be dispatched from works only after receipt of Owner’s written approval of shop test reports.

iii. Type test certificates on any equipment, if so desired by the Owner, shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

25.14.00 **DRAWINGS & DOCUMENTS**

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Design basis report
- Illumination design calculation
- ~~Tubular day light guidance system~~
- GA drawing and single line diagram of lighting distribution board
- GA drawing and single line diagram of lighting panel & receptacle panels
- ~~GA drawing of poles and masts~~
- GA drawing of receptacles
- General arrangement drawings of lighting fixtures
- Lighting design software
- Technical data sheet
- Test reports
- Catalogues



- Illumination layout for other non-plant buildings
- Illumination and Small power distribution arrangement
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

ANNEXURE-I

LIGHTING & LIGHTING TRANSFORMER

S. No.	ITEM	Unit	
1.0	AUXILIARY POWER SUPPLY		
1.1	SYSTEM VOLTAGE		
	Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources.		
1.1.1	A.C Supply		415 Volt, 3 phase, 50hz, 3 wire effectively grounded system Fault level 50kA rms symmetrical
1.1.2	DC Supply		Fault level 25kA symmetrical 220V, 2wire, ungrounded system.
1.2	PERMISSIBLE VARIATION		
	Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:		
1.2.1	A.C Supply		Voltage ±10% Frequency ±5% Combined voltage and frequency 10% (absolute sum)
1.2.2	D.C Supply		Voltage 187 to 242 Volt
3.0	LIGHITNG TRANSFORMER		
3.1	Type		Cast Resin Dry type, encapsulated
3.2	KVA rating		100/50kVA
3.3	Voltage rating		415 V/415 V
3.4	Cooling		AN
3.5	P.U. Impedance		As required
3.6	Voltage control		Off load tap switch/link with change of ±5% in step of 2.5% tapping full capacity
3.7	Class of Insulation		F (155 Deg. C)
3.8	Maximum Temperature rise over 50 Deg C. ambient in winding by resistance		90 Deg. C
3.9	Neutral		Solidly grounded

Notes:

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

ANNEXURE –II

ILLUMINATION LEVELS

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
A.	**TG BUILDING**							
1.	TG Hall Operating Floor	200	20	High/Medium Bay LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
2.	TG Hall Other Platforms/Area	200	20	High/Medium Bay/Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
3.	Cable Spreader Room	100	$A	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
4.	Switchgear Rooms	250	20	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
5.	Main Control Room, Computer Rooms	500	100	LED Luminaire equivalent to Mirror Optics with Antiglare Feature or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
6.	Battery Room	200	-	Totally Enclosed Corrosion Proof LED Luminaire	80%	20%	N	N
7.	Battery Charger Room	200	$B	Industrial Type LED Luminaire for **AC**	80%	20%	Y	N

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
				LED Industrial Bulkhead for **DC**				
8.	Unloading and Maintenance Bay	250	-	High/Medium Bay LED Luminaire	80%	20%	N	N
9.	Air Washer Room/AC Plant Room	200	-	Totally Enclosed Vapour Proof LED Luminaire	80%	20%	N	N
10.	Rectifier Room	200	$B	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
11.	Control Equipment Room	350	100	Decorative Mirror Optics LED Luminaire or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
12.	Offices, Conference Room	300	20	Decorative Mirror Optics LED Luminaire or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
13.	Shift In charge Room	300	$B	Decorative Mirror Optics LED Luminaire or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
14.	SWAS Room	200	$B	Industrial Type LED Luminaire for **AC**	80%	20%	Y	N

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
				LED Industrial Bulkhead for **DC**				
15.	UPS Area	250	$B	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
16.	Lube Oil Room	200	-	Flameproof Well Glass	80%	20%	N	N
17	Pantry	150	-	LED Luminaire	80%	20%	N	N
18.	Toilet Washroom	70	-	LED Luminaire	80%	20%	N	N
19.	H2 Area, Main Oil Tank Area	200	-	Flameproof Well Glass	80%	20%	N	N
20.	Elevator Machine Room	150	-	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	N	N
21.	Elevator Well	50		LED Industrial Bulkhead	100%	-	N	N
22.	Staircase	$C	$A	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	-	-	Y	N
23.	Passage	70	-	LED Luminaire	80%	20%	N	N
24.	Excitation Room	250	$B	Decorative Mirror Optics LED Luminaire or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
25.	Powerhouse Conveyor Floor	150	-	LED dust tight /well glass type luminaire	80%	20%	N	N
26.	Powerhouse Feeder Floor	150	-	LED dust tight /well glass type luminaire	80%	20%	N	N

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
27.	Offices without false ceiling	300	$B	Decorative Mirror Optics LED Luminaire LED Downlighter for **DC**	80%	20%	Y	N
28.	Bunker Floor	150		LED dust tight /well glass type luminaire	80%	20%	N	N
B	**Boiler Area**							
1.	Grade Level	100	20	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
2.	Boiler Platforms	100	20	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
3.	Staircase	$C	$A	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	-	-	Y	N
C	Transformer Yard	20/50	-	LED Luminaire	80%	20%	N	N
D	Compressor Area	150	-	LED medium bay/ Industrial type LED luminaire	80%	20%	N	Y
E	Fuel Oil Pump House	150	-	Flame proof fluorescent fixture suitable for division 2 hazardous area	80%	20%	N	Y
F	**Street Lighting**							
1	Primary Road	20	-	LED Street Light	100%	-	N	N
2	Secondary Road	10	-	LED Street Light	100%	-	N	N
G	Chemical House/ Store	150	-	Corrosion Proof LED Luminaire	100%	-	N	Y
H	**Laboratory**							

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
1	General	150	-	Corrosion Proof LED Luminaire	100%	-	N	N
2	Analysis Area	300	-	Corrosion Proof LED Luminaire	100%	-	N	N
I	Garage/ Car Parking	50	-	Industrial Type LED Luminaire	100%	-	N	N
J	GIS Hall	200	$B	LED medium bay/ Industrial type LED luminaire	80%	20%	Y	N
K	CHP (JT/TT, Crusher House, Conveyor etc)	150	20	LED dust tight/ Well glass type Luminaire for **AC** LED Luminaire for **DC**	100%	-	$D	$E
L	Hydrogen Plant Building	150	-	Explosion Proof HPMV/ Fluorescent fitting suitable for Class – 1 and Division – IIC	100%	-	N	Y
M	Building Periphery Lighting	10	-	LED Street Light/ LED Luminaire	100%	-	N	N
N	Security lighting along boundary	10	-	LED Street Light/ LED Luminaire	100%	-	N	N
O	ESP Area							
1.	ESP Control Room	350	100	Decorative Mirror Optics LED Luminaire or LED Downlighter for **AC** LED Downlighter for **DC**	80%	20%	Y	N
2.	ESP Switchgear Room	250	20	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
3.	ESP Platforms	150	20	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
4.	Staircase	$C	$A	Well Glass LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	-	-	Y	N
5.	Cable Spreader Room	100	$A	Industrial Type LED Luminaire for **AC** LED Industrial Bulkhead for **DC**	80%	20%	Y	N
P	DM Plant/ Water Treatment Plant/ CW Pump House	150	-	LED high/ medium bay/ Industrial Trough LED Luminaire	100%	-	N	Y
Q	Ash Handling Plant	150	-	LED high/ medium bay/ Industrial Trough LED Luminaire	100%	-	N	Y
R	Outdoor Storage Handling and Unloading Area	20	-	LED Luminaire	100%	-	N	Y
S	Cement Stores, Permanent Stores	150	-	Industrial dust proof type LED Luminaire	100%	-	N	N
T	Storage Yard	20	-	Lighting Mast	100%	-	N	N
U	Workshop Building	150	-	LED high/ medium bay/ Industrial Trough LED Luminaire	100%	-	N	Y
V	AIS Switchyard	20/50	-	LED Luminaire	80%	20%	N	N
W	Facility Building, Canteen etc.	150	-	Industrial type LED Luminaire	100%	-	N	N
X	Gate Complex	150	-	LED Luminaire	100%	-	N	N

S. No.	Area	Average Illumination Level (Lux)		Type of Fixture	Lighting System		DC Fixtures	
		AC	DC		ACN	ACE	220V DC	Port-able
Y	Raw Water Pump House/ Fire Water Pump House	150	-	LED high/ medium bay/ Industrial Trough LED Luminaire	100%	-	N	Y
Z	Chimney							
1.	On equipment	150	-	LED Luminaire	80%	20%	N	N
2.	General platform area	70	-	LED Luminaire	80%	20%	N	N
3.	Staircase and landings	100	-	LED Luminaire	50%	20%	N	N

Note:

1. **$A denotes 1 Fixture at every 20 M spacing along walkway.**
2. **$B denotes 1 Fixture at Exit/Entry.**
3. **$C denotes 1 AC Normal Fixture and 1 AC Emergency Fixture to be provided at every alternate landing.**
4. **Fire Exit Sign 1 No. to be provided at all exits.**
5. **In transformer yard & AIS Switchyard lux level shall be 50 (on equipment) and 20 (general).**
6. **$D denotes DC fixtures to be provided as per Cl 25.06.03 (v).**
7. **$E deonotes DC portable emergency lighting unit to be provided in JT/ TT, Crusher House etc except overground portion of conveyors.**
8. **Aviation obstruction lighting system shall be provided both for chimney and NDCT.**
9. **Minimum one (1) light fixture shall be provided at landing in chimney.**

TECHNICAL DATA - PART - A (C&I)

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 B16.11-2009
1.4	Installation schemes		BS 6739-2009, ANSI/ISA 77.70
1.5	Instruments and apparatus for pressure measurement		ASME PTC19.2 (1964)
1.6	Instrument and apparatus for temperature measurement		ASME PTC 19.3 (1974)
1.7	Temperature measurement by electrical Resistance thermometers		IS:2806
1.8	RTD Sensor		DIN-43760 / IEC 60751
1.9	Pitot Tube		ASME (19.5) / ISO 3966-1977
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	**SPECIFICATIONS - RESISTANCE TEMPERATURE DETECTOR (RTD)**		
2.1.1	Type		Three wire / Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.1.2	Standard		DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well
2.1.3	No. of element		Duplex
2.1.4	Housing		Diecast Aluminium
2.1.5	Enclosure Class		IP-65 or better
2.1.6	Head		Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable)
2.1.7	Plug in connectors		Required
2.1.8	Terminal head		Spring loaded for positive contacts with the thermo well
2.1.9	Sheathing of RTD		Metal sheathed, ceramic packed
2.1.10	Sheath Material / Insulation		316SS / Compacted Magnesium Oxide.
2.1.11	Sheath O D		8 mm.
2.1.12	Gauge		18 SWG
2.1.13	Calibration and accuracy		DIN-43760 / IEC 60751 Class-A for RTD
2.1.14	Characteristic		Linear with respect to temp, within ±1/2 percent of top range value.
2.1.15	Insulation Resistance		More than 1000 M Ohms at Ambient temperature
2.1.16	Response Time		6-10 Sec bare & 30 Sec. With protective sheath/thermowell

2.1.17	Instrument Connection		1/2 " NPT (F)
2.1.18	Electrical connection		Gold plated Plug in type. Double entry, one unused entry with blind plug
2.1.19	Process Connection		i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
2.1.20	Extension		Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
2.1.21	Extension neck length		Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
2.1.22	Accessories		Thermo well and associated fittings. Same shall be spring loaded for positive contacts with the well
2.2	**SPECIFICATIONS - THERMOWELL**		
2.2.1	Design		One piece solid bored type of step-less tapered design
2.2.2	Type		SS316
2.3	**SPECIFICATIONS - WIND SPEED SENSOR**		
2.3.1	Principle		Frequency proportional to wind speed
2.3.2	Range	m/sec	0-60 m/ sec
2.3.3	Accuracy	%	2 % of full scale
2.3.4	Threshold	m/sec	0.3 m/ sec
2.3.5	Operating Temperature	DegC	0 to 50 deg C
2.4	**SPECIFICATIONS - WIND DIRECTION SENSOR**		
2.4.1	Principle		Potentiometric type Sensor proportional to Wind direction)
2.4.2	Range	Degree	0-360 degree
2.4.3	Accuracy	%	2 % of full scale
2.4.4	Threshold	m/sec	0.3 m/ sec
2.4.5	Operating Temperature	DegC	0 to 50 deg C
2.5	**SPECIFICATIONS - AVERAGING PITOT TUBE**		
2.5.1	Type/Construction		Averaging Pitot tube with direct mounting type on pipe
2.5.2	Body Materials		SS316
2.5.3	Nipple		SS316
2.5.4	Gaskets		Teflon
2.5.5	Bolts & nuts		SS316
2.5.6	Flange		SS316
2.5.7	Beta ratio		0.4 to 0.7
2.5.8	Process Connection		1 ½" Flanged
2.5.9	Instrument connection		½" NPT (F) through needle valve
2.5.10	Differential range		(To suit the accurate flow)
2.5.11	Accessories		SS316 Bolts, Nuts, Cover plates, Adapter and Gaskets, SS tag plate as required

2.5.12	Tests		Tested at two hundred (200) percent of the Maximum process Pressure. Material Test, Calibration Test.
2.6	**SPECIFICATIONS - INCLINED TUBE MANOMETER**		
2.6.1	Type		Mercury filled clear Borosilicate glass U tube
2.6.2	Range		1. 50-0- 50 mmwcl / 2. 100-0- 100 mmwcl / 3. 200-0-200 mmwcl
2.6.3	Casing		Aluminum on three sides and aluminum cover with clear acrylic front.
2.6.4	Accuracy		0.1 % of FSD
2.6.5	Material		SS304 for Wetted parts & fitting's material other than U tube & manifold
2.6.6	Manifolds		3 valve manifolds & 5 valve manifold of SS316
2.6.7	Accessories		connecting tubes, ½ " NPT process adaptors, range scale, tube chamber, fillup pump, fill up funnel, mounting box, zero adjustment, aspirator, manometer liquid & drain plugs et
2.7	**PRESSURE GUAGE**		
2.7.1	Quantity		One (1) no. in each hot water riser.
2.8	**TEMPERATURE GUAGE**		
2.8.1	Quantity		One (1) no. in each hot water riser.

CONTROL AND INSTRUMENTATION
FOR
NATURAL DRAUGHT COOLING TOWER

Specific Technical Requirements (C&I):

1.1 Bidder to supply the following items as a minimum for each cooling tower:

i) Pressure Gauge and Temp Gauge at each Hot Water pipe riser.
ii) Anemometer (01 no.) for measurement of wind velocity.
iii) Psychrometer (01 no.)
iv) **All motorized valves to be supplied with Non-intrusive Electric actuator**

v) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow.
vi) Local Control Panel for Sump Pumps
vii)Level switches for sump/tank level high/normal/low/very low interlocks.

1.2 The detailed specification of instruments/**Electric Actuator for** motorized Valves is included elsewhere in this specification.

1.3 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.

1.4 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis.

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.
The system shall normally have 2 pumps. The measuring instruments recommended are level switches for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the customer.
The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.

ELECTRIC ACTUATORS

CHAPTER – 17

ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

17.01.00 **SCOPE**

17.01.01 This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

17.01.02 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

17.01.03 Actuators shall be designed to ensure proper function in accordance with specifications given below and complying to EN15714-2 or equivalent.

17.02.00 **CODES & STANDARDS**

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) / IEC mentioned in Chapter 37 except where modified and / or supplemented by this specification.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be furnished during detail engineering.

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

17.03.00 **SERVICE CONDITIONS**

17.03.01 The actuator shall be integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

17.03.02 Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

17.04.00 **RATING**

17.04.01 Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire, 50HZ +/-5%.

17.04.02 Sizing:-

i) For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

ii) For isolating service:- three successive open-close operations or 15 minutes, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

17.04.03 Control voltage of the motor starter shall be 110V AC. Power supply to electrical actuators shall be backed up with reliable battery supply.

17.05.00 **PERFORMANCES**

The actuator shall meet the following performance requirements:

17.05.01 Open and close the valve completely and make leak-tight valve closure, without jamming.

17.05.02 Attain full speed operation before valve load is encountered and impart an unseating blow to start the valve in motion (hammer blow effect).

17.05.03 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

17.05.04 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

17.05.05 The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

17.06.00 **SPECIFIC REQUIREMENT**

17.06.01 Construction

i) The actuator shall essentially comprise the drive motor, torque/ Position limit switches, gear train, clutch, hand wheel, position indicator and transmitter, inbuilt thermostat for overload protection, single phase preventer protection, space heater and internal wiring. Actuator shall be integral type. Integral starters shall have two sets of torque and limit switches for independent hook-up with plant DCS logic and electrical logic/interlock. All actuators shall be certified for SIL 2 or better.

ii) The actuators shall be Non-intrusive electric actuators with accessories. All actuator settings including torque, limit shall be possible without opening the actuator cover and LCD indication shall be available integral to actuator body.

iii) The actuator enclosure shall be totally enclosed, dust tight, weatherproof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

iv) All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

v) The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

vi) A lockable local/remote selector switch shall also be provided for selecting mode of operation.

vii) Gear Train:-Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

viii) Manual Wheel:- Shall disengage automatically during motor operation.

ix) Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust

x) The integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system.

xi) A three-position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

xii) The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.

xiii) The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring. The local status display of actuator shall be clearly understandable by operator (Display of instruction should be clearly mentioned in the name plate i.e., operation alarm and fault indication).

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

xiv) The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

xv) View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

xvi) Electronic overload relay shall be provided to trip actuator in case of overload. Plug in connections/design shall be provided between:

- Integral starter unit and basic actuator
- Between external customer connections and actuator

xvii) OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

xviii) Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

xix) All required accessories (if applicable) for calibration/ settings/ configuration of various parameters of actuator shall be provided.

17.06.02 Motor

i) The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

ii) The actuators shall be sized so as to open or close valves/ dampers at rated speed.

iii) Motor insulation shall be class B or better. With Temperature rise not more than 70 degree 'C' over ambient temp. of 50 deg.C. The actuators shall be suitable for a relative humidity of 95%.

iv) Performance:-The motor shall be capable of:

a) Starting at 85% of rated voltage
b) Running at 80% of rated voltage at rated torque for 5 minutes
c) Running at 85% rated voltage at 33% excess rated torque for 5 minutes.

v) Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

vi) Bearing

The motor bearing shall be double shielded, grease lubricated and antifriction type.

vii) Earthing

At least two earthing terminals shall be provided for the motor body. Separate earting terminal should be provided for terminal box.

viii) Protection:-The following electrical protections should be provided for the motor:-

a) Single Phasing Protection
b) Overload Protection
c) Overheating protection through thermostat
d) Wrong Phase Sequence Protection

ix) The actuators shall be designed to be self locking upon loss of power. Motor shall be designed to close in 30 secs from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

x) The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

17.06.03 Limit Switches

i) Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.

ii) Each motor actuator shall also have two (2) torque limit switches with two (2) normally opened and two (2) normally closed contacts each.

iii) The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

iv) The motor operators/actuators shall be capable of meeting 150 percent of unseating torque at specified voltage.

v) The motor actuators shall have 2 nos. potentiometric type transmitters of 100-ohm rating.

vi) Torque switches shall function to stop the motor on closing/opening. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be self-resetting type only (i.e.) once a particular direction torque switch operates, it shall get resetted only when the equipment is operated in other direction.

vii) All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

17.06.04 Position Indicator/Transmitter

i) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

ii) To be provided for 0 to 100% travel.

iii) As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

17.06.05 Hand Wheel

Hand wheel shall enable manual operation in case of power failure but it shall get automatically disengaged when once the motor starts functioning. The effort required to operate manually shall not exceed 18 Kg.

17.06.06 Space Heater

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

17.06.07 Terminal Box

i) The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

ii) 1100V grade for power cables.

17.06.08 Wiring

i) All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards mounted on the valve, having liberal space for wiring and making connections to Owner's external circuits. Plug in type/ screw terminals shall be used suitable for analog/digital application. There shall be at least 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

ii) Motor terminal box and actuator terminal box shall be provided with double compression cable glands to suit cable type and size and copper lugs for cables.

iii) Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor.

17.06.09 Interfaces:

i) Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

ii) The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.

- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip
- And as also as per drive control philosophy

iii) Interface with the control system shall be through hardwired signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

iv) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided.

iv) Open/close command termination logic shall be suitably built inside actuator.

17.06.10 Name Plate

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

17.06.11 Painting

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be as mentioned in Chapter 1.

17.06.12 Packing

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

17.06.13 Overload Protection

The actuator motor shall be provided with integral starter along with thermostat for overload protection.

17.06.14 Tests

i) The actuator and all components thereof shall be subject to routine factory tests as per relevant IS Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

ii) Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

iii) The actuator shall be type tested as per IEC/National Standard, by international/national recognized test house. The test certificates issued by this house shall be furnished.

iv) Test Witness

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

DATASHEET

1.0	**Auxiliary power supply**	
1.1	415V, 3Φ, 3W, 50 Hz. Fault level 50 kA symm for 1 sec.	Motors above 200 W and including 160kW
1.2	240V, 1Φ, 2W, 50 Hz effectively earthed	Motors including 200 W and below. Lighting, space heating, AC control and protective devices
1.3	**DC supply**	
	220V,2W, unearthed. Fault level 25 kA for 1 sec.	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2.0	**Range of variation**	
2.1	AC supply	
	voltage	± 10%
	Frequency	± 5%
	Combined voltage & frequency	10% (Absolute sum)
2.2	DC supply	187 to 242 V

2.02.00 Specification for Pressure Gauge, D.P Gauge, Temperature Gauge and Level Gauge

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	**Temperature gauge**	**Level Gauge**
1	Sensing Element and Material	Bourdon for high pressure, Diaphragm/ Bellow for Low pr. Of SS 316	Mercury in Steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary	Tempered * toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body Material	Die Cast Aluminum with stoved enamel black finish /SS316	Die Cast Aluminum with stoved enamel black finish /SS316	Forged carbon steel/SS 304
3	Dial Size	150 mm with toughened shatter proof glass	150 mm with toughened shatter proof glass	Tubular covering entire range
4	End Connection	½ inch NPT (M)	¾" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	+/- 1% span	+/- 1% span	+/- 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range Selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale
8	Over range test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C		
9	Housing	Weather and dust proof as per IP-65	Weather and dust proof as per IP-65	CS/304 SS leak proof.

S. No.	Features	Essential minimum requirements		
		Pr. Gauge/DP Gauge/Draught gauges	**Temperature gauge**	**Level Gauge**
10	Zero/span Adjustment	Provided	Provided	-
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out Disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS316 Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of CS/ alloy steel/SS as per process requirement.
13	Material of Bourdon/ movement	SS 316	SS 316	

Notes – *Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

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 inert liquid suitable for the application.

For condensate storage tank and DM water storage tanks, the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

S. No.	Features	Essential/Minimum Requirements
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

Notes

1. Extension cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

2. Thermocouples provided for steam services like super heater / de super heater area, where the process pipe is inside the insulation of boiler penthouse, Thermowells are inaccessible and terminal head and connecting cable cannot withstand high temperature, for such services thermocouples shall be provided with flexible extension SS316 Sheath of 10-15 meters.

3. Bidder may also provide Triplex Thermocouples as per process requirements.

4. Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.06.02 Resistance Temperature Detector (RTD)

S. No.	Features	Essential/Minimum Requirements
1.	Type of RTD	Three wire/Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2.	No. of element	Duplex
3.	Housing/Head	IP-65/Diecast Aluminum. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable). Plug in connectors are to be provided for external signal cable connection.

S. No.	Features	Essential/Minimum Requirements
4.	Sheathing of RTD	Metal sheathed, ceramic packed
5.	Calibration and accuracy	As per DIN-43760/IEC 60751 Class-A for RTD
6.	Characteristic	Linear with respect to temp, within ±1/2 percent of top range value.
7.	Accessories	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well
8.	Standard	DIN-43760/IEC 60751 for RTD and ASME PTC-19.3 (latest edition) for Thermo-well.
9.	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide.
	Sheath O D	8 mm.
	Gauge	18 SWG
10.	Insulation Resistance	More than 1000 M Ohms at Ambient temperature
11.	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
12.	Instrument Connection	1/2 " NPT (F).
13.	Electrical connection	Gold plated Plug in type. Double entry, one unused entry with blind plug.
14.	Enclosure Class	IP-65 or better.
15.	Process Connection	i) M33 x 2 ii) Flanged for Air & Gas systems with mating flanges, fastner, gasket etc.
16.	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
17.	Extension neck length	Minimum 100 mm above Insulation of pipe and Minimum 160 mm when there is no insulation on pipe.

NOTES:

1) The specifications for RTDs of winding/ bearings of motor/ pump can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However the type of RTD shall be PT100.

2) Metal plug with chain is to be provided with thermowell to avoid ingress of foreign material inside thermowell when TE is not fitted or during maintenance.

2.13.00 PROCESS ACTUATED SWITCHES

S. No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	**Temperature switches**	**Level switches**
1	Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type for applications as decided by owner during detailed engineering. Capacitance/Conductivity/Ultrasonic type for acid and alkali application. RF/ Ultrasonic type for ash hopper, ash slurry

S. No.	Features	Essential/Minimum Requirements		
		Pressure/Draft Switches/ DP Switches	**Temperature switches**	**Level switches**
				application. Detailed spec are also included below.
2	Material of sensing element & movement.	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
3	End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard
4	Over range proof pressure	150% of max. design pr	-	150% of max. design pressure
5	Repeatability	± 0.5% of full range		
6	No. of contacts	2 Nos. +2NC. SPDT snap action dry contact. Auto reset with internal Adjustable snap action micro switch. Differential shall be adjustable.		
7	Rating of contacts	60 V DC, 6 VA (or more if required by DDCMIS/PLC)		
8	Elect. Connection	Plug in socket		
9	Set point	Provided over full range. Differential shall be adjustable.		
10	Dead band adjustment	Adjustment upto 10% at set points.		
11	Enclosure	Die cast Aluminum with stoved enamel black finish/SS316, Weather and dust proof as per IP-65. Epoxy painting shall be provided for corrosive atmosphere.		
12	Accessories	Siphon, snubber, chemical, pulsation dampers as required by process.	Thermo well of 316 SS and packing glands	All mounting accessories
13	Mounting	Suitable for enclosure/rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
14	Power Supply (wherever Required)	24 V DC, to be arranged by Bidder except for Ash Level Switches, where the same shall be as per Bidder's Standard practice.		

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) Pressure / Diff Pressure switches for very low pressure / DP measurements can have sensor material other than SS316 e.g. silicon etc., if the offered material is suitable for that application and the offered product is standard product of the manufacturer for very low pressure applications.

3) Repeatability can be upto +/-1% of full range in case of switches with diaphragm seals or very low pressure/DP range.

4) All the Pressure/ Diff. Pressure/ Temp./ Level switches etc. shall be with the provision of local digital display.

2.17.00 AC PLANT AND COMPRESSOR RELATED SPECIAL INSTRUMENTS

2.17.01 (HUMIDITY SENSOR)

Sensor	:	Capacitance type
Accuracy	:	+/-3% R.H
Range	:	0-100%
R.H Output	:	4-20 ma
Time constant	:	2 mins.

Output from the sensor is to be connected to respective control system. Bidder can also provide combined instrument for measurement of humidity and temperature subject to Owner's approval during detailed engineering. In all such cases, 4-20 ma outputs, each for temperature and humidity measurements are to be provided.

2.17.02 TEMPERATURE/ HUMIDITY INDICATOR

Sensor	:	RTD for (Pt 100) for temperature
	:	Capacitance Type for Humidity (specs for humidity and temperature shall be as mentioned above)
Display	:	Combined enclosure with two three digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of at least 10 meters.
Range	:	0-60 Deg C for temperature.
	:	0-95.0 % for Relative Humidity.
Accuracy	:	Better than +/_0.5 % for Temperature
	:	Better than +/_2.5 % for Relative Humidity
Mounting	:	Table Top/ wall mounting.
Power supply	:	240 V AC, 50 Hz.
Output	:	4-20 mA signal each for temperature.
Qty.	:	15 nos. each of temperature & Humidity indicators (combined indicators for Humidity and temperature is also applicable).

One Set of output signal is to be connected to respective control system. Apart from displaying the temperature/humidity values on indicator.

2.17.03 DEW POINT METER

Type	:	2 Wire Loop Powered Dew point Transmitter
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	± 2°C Dew point
Material	:	SS316 (wetted parts)
Features	:	a) AUTOMATIC CALIBRATION

(b) Can be Configured for Linear 4-20mA signal in °C & °F Dewpoint, ppm(v), ppb(v), g/m3
(c) Temperature Compensation
(d) Failure Diagnostics
(e) Long Term Stability
(f) Fast Response
(g) IP 66 / NEMA4X Protection
(h) Supplied with Calibration Certificate Traceable to National & International Humidity Standards
(i) Sensor protection with sintered filter
(j) Local LCD Display for Dew Point

2.18.00 Limit switches

For offsite plant application Limit switches shall be gold plated with high conductivity and non corrosive type. Contact rating shall be sufficient to meet the requirement of DDCMIS subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP 65. Contact shall be either 1 no, DPDT or 2 nos. SPDT minimum.

For main plant application, limit switches are to be provided as per bidder standard and proven practice.

All limit switch shall be conform to IEC-60947-5-1.

CHAPTER – 8

PROCESS CONNECTION AND PIPING

8.00.00 PROCESS CONNECTION PIPING

8.01.00 The Bidder shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this chapter, enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipments (provided by the bidder) to the process on as required basis for the connection of all instruments and control equipments of entire plant.

The installation and source connection of various items shall generally as per NIT installation drawings (Drawing No. 114-04-0000, 0100 to 0113 and 114-18-0100), however, the bidder shall furnish during detailed Engineering. Installation drawings, GA and fabrication drawings of LIES/LIRs, other relevant drawings, material and tech data sheets of various items service wise for owner's approval/information.

8.01.01 All material, furnished under this chapter and the installation there of shall conform to the latest editions of American National standard Code for pressure piping, power piping ANSI B 31.1, ANSI B16.11, ASME Boiler and pressure Vessel codes, IBR and other applicable ASME, ANSI and state standards.

8.01.02 All material supplied under this chapter shall be suitable for intended service, process, operating conditions and type of instructions used and shall fully conform to the requirements of this specification. The bidder is responsible for the performance of equipments furnished under this specification on system basis. The bidder may offer suggestions for improvement based on his experience, during detailed engineering, which shall be subjected to the Owner's approval.

8.01.01 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

8.01.02 All impulse pipes shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The size of impulse pipe shall be ½" for steam and water applications and ¾" for air and flue gas applications. The material of impulse pipe shall be same as that of main process pipe. For various applications specification of impulse pipe matrials and associated fittings and valves shall be as given in table 8.1. For protection against sea environment, all impulse pipes, fittings etc shall be provided with durable epoxy coating with poly urethane finish.

8.01.03 SS tube shall be provided inside enclosures& racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A, B, C & D of the table no 8.1) the material shall be ASTM A 213 TP 316H it and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the

ANSI B31.1 standard. The bending radius of the tube shall be greater than 6D.

8.01.04 All fittings shall be forged steel and shall conform to ANSI B16.11. The matrial of forged tube fittings for shaped application (e.g. tee, elbow etc) shall be ASTMA 182 Gr 316 H for high pressure/temperature applications (as defined above) and ASTMA 182 Gr 316 L for other applications. The matrial for bar stock tube fitting (for straight application) shall be SS 316. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with they are to be used.

The source shut off (primary process root valve) and blow down shall be ½ inch size globe valve type for all applications except for air and flue gas service wherein no source shut off valves are to be provided. For various applications the valve body materail, stem material and pressure class shall be as given in table 8.1. The end connections of valves shall be of socket welded type unless otherwise specified in the instrument installation diagrams. The disc and seat ring material of carbon Steel and alloy steel valves be ASTM-A-105 and ASTM-A-182 Gr F22, hard faced with satellite (minimum hardness-350 BHN). The surface finish of 16 RMS or grater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

For Pr/D.P. gauges in fluid application two way globe valve on each impluse line to the instrument and in air/flue gas application two way gate valve on each impulse line to the instrument shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the Pressure/Differential pressure gauges.

The rating of material of impulse pipes, tubes, fittings, valves and their installation thereof shall conform to the latest edition of standards as per following table:

Impulse Pipe, Tube (material & rating)	ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
Valves (Material Pr. Class, size)	ASTM A 182/ ASTM A 105 as per ASME 16.34
Fitting (Size, rating, material)	ANSI B31.1, ANSI B31.1a, ASME B16. 11-2009
Installation Scheme	BS 6739-2009, ANSI/ISA 77.70

Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. Two root valves are to be used wherever pressure is >/= 40 Kg/cm2 or Temp>/=280 deg C. The end connections of valves shall be of socket welded type.

8.01.03 The valve manifolds of 316 SS with pressure rating suitable for intended application shall be provided as given below:

Manifold	**Application/Measurement**
2 Valve	Pressure measurements using pressure transmitters/pressure switches.
3 Valve	Pressure measurements using differential pressure transmitter/switches.
5 Valve	Differential Pressure, Flow and Level Measurements

For Pr./D.P gauges, two-way globe/gate valve shall be provided on each impulse line to the instrument in Fluid/Air & Flue Gas applications respectively .

8.01.04 Double ferruled compression type fittings shall be used only, wherever required.

LOCAL CONTROL PANEL

CHAPTER – 6

SUPERVISORY CONTROL PANELS, SUPERVISORY CONTROL DESKS, EQUIPMENT PANELS

6.00.00 CONTROL DESK & PANELS

6.01.00 General

6.01.01 All control desk, panels, LVS panel etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti- vibration pads, internal piping & accessories as required for completeness of the system.

All panels, desks, cabinets shall be free standing type & have bottom / top entry for cables to be finalised application wise during detailed engineering stage. The bottom of desk & cabinets shall be sealed with bottom plate, compression cable glands (double for field and single for inside rooms) and fire proof sealing material to prevent ingress of dust and propagation of fire. Sufficient number of power receptacles with disconnect switches shall be installed within all panels/desk.

6.01.02 Exterior steel surface shall be sand blasted, ground smooth, filled, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. The exact color shall be finalised during detailed engineering.

6.01.03 The design shall conform to the EN ISO 11064-6:2005 (Ergonomic design of control centres, Part 6/latest). Bidder shall furnish documentary proofs/ evidences/certifications in support of same along-with the Bid, stating compliances for the entire aspects covered under the ISO standard.

6.02.00 CONTROL DESK & PANEL

6.02.01 The exact dimensions, material, construction details, grounding, general arrangement etc. of Control Desk etc. shall be as per the actual requirement and shall be finalised during detailed engineering and subjected to Owner's Approval. For bidding purpose, the minimum length of the desk/ panel and CD mounted devices are given in Appendix-I to Part-A, Volume V.

6.02.02 For control desk mounted instruments/ devices etc., which are to be powered from UPS, all required conversion of interface equipments / accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like Input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS, redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.

6.10.00 **CONSTRUCTIONAL FEATURES OF LOCAL CONTROL PANELS, CONSOLES, CONTROL Desk, CUBICLES & ENCLOSURES**

i. All type of panels, control panels, cubicles, consoles, SOV panels, GIU panels, Fire alarm panels and enclosures provided anywhere for subject plant per this specification shall be of free-standing type with modular construction and shall be constructed of specified gauge of sheet steel (Industrial grade- Grade D) as per IS 513 depending on location with Multi-folded frame-based structure (Minimum 9-folded Profile) made from a single sheet. Panels with multi folded profiles shall be mandatory for all types of DDCMIS, DCS and PLC panels. The minimum sheet thickness of panels shall be as follows unless otherwise specified herein.

Side and top – not less than 1.5 mm
Door – not less than 2.0 mm
Mounting plate –3mm GI
Base metal plate - 2.5 mm
Gland plate – 3 mm

ii. The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Doors shall be reversible type, left hinged as a default, with 130-degree swing. Door latches shall be of the four - point type to ensure tight closing. Door locks shall be furnished which

will allow actuation of all locks by a single master key. All panels shall have removable lifting eyebolts for safe lifting from top during storage and installation handling. Doors should come with double bit cam locks to ensure rigid and inposition locking which provides consitent IP protection and avoids entry of external substances/dust/water.

Cabinet doors shall be hinged and shall have turned back edges and additional braking where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of four -point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is equal or more than 800 mm, double doors shall be provided.

iii. All panels shall be mounted on vibration dampers, which are secured to C- channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry. Properly installed grounding and potential equalization of various electrically conductive parts in order to compensate for voltage differences between conductive parts shall be preliminary design requirement for all the panels/enclosures to be met by the Bidder.

iv. In each panel /cabinet installed in common control room a 24 VDC/ 230 VAC Voltmeter digital type shall be provided to check all the (AC/ DC) Field Interrogation voltage.

v. Exhaust Fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.

vi. Fire & Smoke detectors shall be provided inside the Control room mounted system/control cabinets.

vii. Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to DDCMIS/PLC/annunciation & suitably grouped.

viii. All the panels shall be equipped with Anti vibration pad of min. 15 mm size thickness. Cable gland plate thickness shall be 3 mm. C Channel height shall be min. 100 mm.

ix. Doors shall be provided with polyurethane gasket only (Durometer hardness as per ASTM D2240-97/e1) with sustainable IP throughout product life. The front and rear doors shall be of full height.

x. Protection class shall be as specified at Vol. V, Part B, chapter 1.

xi. All the cable entries shall be at the bottom of electronic cubicles/control Panels.

xii. Control panels shall be provided with proper arrangement and hardware to terminate the inert gas required for fire protection.

xiii. 25x6 mm copper ground bus to be provided for each panel/control desk.

xiv. Terminal blocks shall be Rail mounted 650 V AC grade Terminal blocks (Screw less cage clamp type) with markers and 20% spare wired terminals of each type.

xv. For Panels/cubicles internal wiring details, Bidder to refer Vol. V, Part B, Chapter 9.

xvi Salt spray tests shall be conducted in accordance with ISO 9227:2012(en) i.e. Corrosion tests in artificial atmospheres.

xvii. Enclosure Protection class against external mechanical stresses shall be of IK09 standard as per EN 50102/IEC 62262 for all type of panels/enclosures. Dynamic material strength and vibration resistance shall be as per IEC 60068-2-6.

xviii. Complete panels/enclosures for project plant shall be tested and certified according to manufacturing standard IEC 62208. (the IEC 62208 standard requires the IP and IK to be declared and verified)

xix. Complete panels/enclosures for project plant shall be tested and certified for level C4H, high corrosivity according to ISO12944 (> 15 years to first major maintenance)

xx. Complete panels/enclosures for project plant shall be RoHS compliant, UL and TÜV Rheinland certified and shall be tested/certified according to IEC 60529 and latest IEC 62262 standard (i.e the latest applicable standard at the time of bid opening)

xxi. Complete panels/enclosures for project plant shall be Tested and certified according to Electrical protection Class II IEC 60950-1, IEC 61439-1 standard, UL508A standard, IEC 60297-3-100 standard and IEC 61696-3 standard.

xxii In each panel /cabinet installed in Common Control Room (CCR) a temperature indicator digital type shall be provided for monitoring of temperature of individual panels/ cabinet.

xxiii All the control panels shall be separated power and instruments/ electronic grounding.

xxiiii The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise

does not exceed 10 deg. C above the ambient under the worst conditions.

xxiiv Enclosures for peripheral equipment like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.

xxiv All panels, desks, shelters, cabinets, consoles & enclosures installed under the open/outdoor environment shall be provided with lightening protection system as per system requirements.

xxivi Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 3.0 mm for load bearing sections (Mounted with instruments)
2.0 mm for doors and Not less than 2.0 mm for others
Panel Height: Not less than 2365 mm
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte

Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for
Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

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	Total differential pressure drop		
11.1	Drop through louvers	mm of H2O	
11.2	Drop through fills	mm of H2O	
11.3	Drop through eliminators	mm of H2O	
11.4	Velocity pressure	mm of H2O	
11.5	Drop through plenum	mm of H2O	
12.0	Basin Storage capacity	M3	
13.0	Plan Dimensions (Diameter)	M	
14.0	Overall Size of Cooling Tower (Plan Dimensions X Height)	M x M	
15.0	Required Pumping Head including all losses measured from basin, curb level	M	
16.0	Cooling Tower Levels		
16.1	Graded Level	M	
16.2	Maximum Water Level	M	
16.3	Basin Curb Level	M	
16.4	Minimum Water Level	M	
16.5	Basin Bottom Level	M	
17.0	Overall Tower Height from Basin Floor	M	
18.0	Basin Dimensions		
18.1	Diameter	M	
18.2	Depth (from basin curb)	M	

19.0	Free Board (Above Max. Water Level)	mm	
20.0	Heat Transfer Data		
20.1	Heat Transfer Coefficient (K)		
20.2	Tower Coefficient © Ka V/L		
20.3	Average Fill Height	M	
20.4	Total Fill Volume	Cub M	
20.5	Total Tower Wetted Surface	Sq M	
21.0	Hot Water Distribution Piping		
21.1	Size (OD X Thk)	mm x mm	
21.2	Elevation of Center Line of Hot Water distribution Header	M	
21.3	Design pressure for Hot Water Distribution System	Kg/cm2 (g)	
22.0	Isolation Valves in Hot Water Risers (As applicable)		
22.1	Size	mm	
22.2	Quantity	Nos./ cell	
22.3	Type/Code & Standard		
22.4	Make		
22.5	Pressure drop across the valve in fully open position	MWC	
22.6	Materials of Construction		
22.6.1	Body		
22.6.2	Disc		
22.6.3	Drive Shaft/Stub Shaft		
22.6.4	Bearings		
22.7	Test Pressure / duration	Kg/cm2 (g) / Min.	
23.0	Flow Control Valves (If Applicable)		
23.1	Make & Type		
23.2	Size	mm	
23.3	Qty.	Nos	
23.4	Materials of Construction		
23.4.1	Body		
23.4.2	Spindle		
23.4.3	Trim		
24.0	Isolating Valve in Sludge Pit		
24.1	Size	mm	
24.2	Quantity	Nos / CT	
24.3	Type		
24.4	Make		
24.5	Conform to which code in respect of design/testing		
24.6	Materials of Construction		
24.6.1	Body		
24.6.2	Stem		
24.6.3	Trim		

25.0	**Stationary Screen**		
25.1	Quantity	Nos / CT	
25.2	Size & Material of Bar		
25.3	Clear Space between the bar		
25.4	Lifting Arrangement		
26.0	**Fill & Fill Supports**		
26.1	Type of fill		
26.2	Material		
26.3	Expected Life	Years	
26.4	Arrangement of Fill/splash bars (horizontal etc.)		
26.5	Method to prevent dislocation of Fills		
26.6	Type/Material/Size of fixing arrangement to supporting grid		
26.7	Fill Support Grids		
26.7.1	Type		
26.7.2	Material (give full specification)		
26.7.3	Size		
26.7.4	Colour of Fill		
26.8	Grid Supporting Frames		
26.8.1	Type		
26.8.2	Material (give full specification)		
26.8.3	Size		
26.10	Fasteners		
26.10.1	Type		
26.10.2	Fill		
26.10.3	Fill Support Grids		
26.10.4	Frames for Supporting the Grids		
27.0	Drift Eliminators		
27.1	Number of Passes		
27.2	Gross Face Area per pass	Sq M	
27.3	Type		
27.4	Eliminator Blades		
27.4.1	Material		
27.4.2	Maximum Length of blade	mm	
27.4.3	Size and shape of blades		
27.4.4	Type and material of drain boards		
27.5	Blade Support Spacers		
27.5.1	Type		
27.5.2	Material		
27.6	Support for spacers		
27.6.1	Type		
27.6.2	Material		
27.7	Fasteners		

27.7.1	Type		
27.7.2	Material		
28.0	**Gate in Cold Water Outlet Channel**		
28.1	Number per cold water outlet channel		
28.2	Gate Type		
28.3	Name of Manufacturer		
28.4	Gate Size		
28.5	Weight of each gate	Kg	
28.6	Are elements of gate dismantling type?		
28.7	Weight of each Element	Kg	
28.8	Frame Type		
28.9	Fixing arrangement of frame with RCC channel		
28.10	Lifting Arrangement of Gate		
28.11	Expected Life	Years	
29.0	**SLUDGE PUMP & MOTOR (Optional Item)**		
29.1	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	Shell		
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		
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		

NATURAL DRAUGHT COOLING TOWER

1.0	Total design capacity (per tower)	Cum/hr	:
2.0	Type of air flow to water flow		:
3.0	Water inlet temperature	Deg.C	:
4.0	Recooled water temperature	Deg.C	:
5.0	Design ambient wet bulb temperature	Deg.C	:
6.0	Design approach	Deg.C	:
7.0	Design atmospheric relative humidity	%	:
8.0	Wind velocity for performance	KM/PH	:
9.0	Cooling Range	Deg C	:
10.0	Evaporation loss (at design capacity)		:
11.0	Drift loss (at designed capacity)		:
12.0	**LEVELS**		
12.1	Finished grade level below sill	M	:
12.2	Level of basin bottom below sill at periphery	M	:
12.3	Level of basin bottom below sill at center	M	:
12.4	Normal working level of water in basin below sill	M	:
12.5	Free board above max. water level in basin.	M	:
12.6	**Velocity** of water at the CT outlet. connecting with CW lead channel	m/sec	:
13.0	**HEIGHTS**		
13.1	Height of top of tower above sill	M	:

13.2	Height of throat of tower above sill	M	:
13.3	Height of top of air inlet above sill	M	:
13.4	Height of top of fill above sill at periphery and center	M	:
13.5	Height at top of the drift eliminators	M	:
13.6	Height of bottom of fill above sill at periphery and center	M	:
13.7	Height of hot water riser center line above sill	M	:
13.8	Total weight of water in basin (maximum)	Metric tonne	:
13.9	Area of water surface in basin	Sq.M	:
13.10	Height of surge shaft		:
14.0	**DIAMETERS**		
14.1	Internal diameter of tower at sill level	M	:
14.2	Internal diameter at top of air opening	M	:
14.3	Internal diameter at throat of tower	M	:
14.4	Internal diameter at top of tower	M	:
14.5	Basin volume at maximum water level	M^3	:
15.0	**EFFECTIVE FILL VOLUME**	Cum	:
15.1	Effective cooling surface of fill	Sq.M	:
15.2	Cooling water flow (L) Kg per square meter fill area per hour	Kg/m^2/ hr	:
15.3	Dry air flow (G) Kg per metre fill area per hour	Kg/m^2/ hr	:

15.4	Correction in G or effect of cross flow, if any		:
15.5	Ratio of water to air weight	(L/G)	:
15.6	Is leaving Air saturated*	Yes/No	:
15.7	Temperature of leaving air wet bulb / dry bulb	Deg.C	:
15.8	Total dry air flow per tower	Kg/hr	:
15.9	Inlet air enthalpy above zero degree C	Kcal/kg	:
15.10	Sensible heat gain by dry air through tower	Kcal/kg	:
15.11	Latent heat gain by dry air	Kcal/kg	:
15.12	Exit air enthalpy above zero degree C	Kcal/kg	:
15.13	Total heat exchange per kg of dry air inlet	Kcal/kg	:
15.14	Total heat exchange per hour	Kcal/kg	:
15.15	Evaporation loss maximum (state conditions)	Kg/hr	:
15.16	Drift loss maximum (state conditions)	Kg/hr	:
15.17	Blow down for maintaining the required concentration (state conditions)	Kg/hr	:
15.18	Total loss	Kg/hr	:
15.19	Density of ambient air	Kg/m^3	:
15.20	Density of exit plume	Kg/m^3	:
15.21	Velocity of air	M/s	:
	a) above sill of basin		:
	b) air opening		:
	c) tower throat		:
	d) top of tower		:

Note : (* Furnish air flow, water flow and cooling tower characteristics curve on Psycometric chart).

16.1	Wetted fill surface per sq.metre tower area (enclose calculation) (film type)	M^2	:
16.2	Fill film type surface (enclose calculations)	M^2	:
16.3	Mass transfer co-efficient (K)	Kg/hr/sq.m	:
16.4	Tower co-efficient (enclose calculations)	$\frac{KaV}{L}$	:
16.5	Draft loss (static and dynamic)	mmwc	:
	a) Inlet of fill		:
	b) Through fill area		:
	c) Through eliminators		:
	d) Through distribution pipe /troughs etc.		:
	e) Total		:
16.6	Pumping head at hot water terminal head (enclose calculations)		:
	a) Friction losses in distribution system beyond terminal point	mmwc	:
	b) Static height from normal water level in basin to max. water level in distribution trough	mwc	:
	c) Total	mmwc	:
16.7	Draught factor (enclose calculations)		

Draught factor

$$\frac{P}{1.64 \times 10^{-8}}$$

P = density difference in air at inlet and exit of tower in lbs/cu.ft

h = total enthalpy difference of air at inlet and exit of tower in Btu/lb

16.8	Equivalent packing surface area per cubic metre of packing (a)	M^2/m^3	;
16.9	Depth of packing (V)	M	:
16.10	Performance coefficient		

$$C = \frac{M}{(L/GN)\ 1/3}$$

M = Merkels factor (furnish separately)

N = Resistance of tower to air flow through it, in number of velocity heads lost (furnish separately)

16.11	Duty coefficient (D)		:
	D = A/H		:
	A = Pond area at sill level		:
	H = Performance co-efficient		:
16.12	Pressure loss co-efficient of water	$(kg/cm^2)/m^3/hr)$	:
17.0	**SHELL**		:
17.1	Material		:
18.0	**BASIN**		:
18.1	Material of basin		:
18.2	Area of basin at normal water level	Sqm	:
18.3	Volume of basin	Cum	:
19.0	**FILL**		
19.1	Type		:

19.2	Total height	m	:
19.3	Total surface area	Sq.M	:
19.4	Fill louver span	M	:
19.5	Packing deflection	mm	:
19.6	Material of fill		:
19.7	Material of fill supports		:
19.8	Shape and thickness (enclose dimensional sketch)		:
19.8.1	Margin for wear and tear	mm	:
19.9	Manner of support and jointing		:
19.10	Packing for preventing vibrations (furnish details)		:
20.0	**DRIFT ELIMINATORS**		:
20.1	Type		:
20.2	Arrangement		:
20.3	Material		:
20.4	Size and thickness		:
21.0	**WATER DISTRIBUTION SYSTEM**		
21.1	Primary troughs/pipe		:
21.1.1	Material		:
21.1.2	Shape and size (cross sectional area for water flow)	(Sq.cm)	:
21.1.3	Thickness		:
21.1.4	Velocity of flow	M/sec	:
21.2	Secondary trough / pipe		:
21.2.1	Material		:
21.2.2	Shape and size (cross sectional area for water flow)	(Sq.cm)	:
21.2.3	Thickness	mm	:

21.2.4	Velocity of flow	M/sec	:
21.3	Orifice / Nozzle		:
21.3.1	Material		:
21.3.2	Size – capacity each (enclose cross-sectional drawing)	Litres/ sec	:
21.3.3	Thickness	mm	:
21.4	Feed Pipes		:
21.4.1	Material		:
21.4.2	Size (D)	mm	:
21.4.3	Thickness	mm	:
21.4.4	Velocity of flow	M//sec	:
21.4.5	Number		:
21.5	Splash Plates or Cups		:
21.5.1	Material	Sq.M	:
21.5.2	Size	mm	:
21.5.3	Thickness	mm	:
21.5.4	Margin for wear and tear	mm	:
21.6	Surge shaft height dia	mm	:
22.0	**TREATMENT PROPOSED FOR CENTRE INTERNAL SURFACES (FURNISH DETAILS)**		
23.0	**MISCELLANEOUS MATERIALS**		:
23.1	Drain valves		:
23.1.1	No. of valves included		:
23.1.2	Size		:
23.1.3	Specification		:
23.2	Drain Piping		:
23.2.1	Material		:
23.2.2	Specification		:

23.2.3	Size		:
23.2.4	Quantity included		:
23.2.5	Type of joints		:
23.3	Hot Water Pipework		:
23.3.1	Piping as per code		:
23.3.2	ID x Thickness	mm	:
23.3.3	Design pressure	Kg/cm^2	:
23.3.4	Enclosed cross section drawing of pipe		:
23.3.5	End connection details at TP		:
23.4	Slide Gates		:
23.4.1	Type and conforming to IS		:
23.4.2	Overall dimensions		:
23.4.3	Total weight		:
23.4.4	Ref. To dimensional drawings enclosed Lifting Arrangement		:
23.5	Coarse Screen		
23.5.1	Type and conforming to IS		:
23.5.2	Overall dimensions		:
23.5.3	Size of mesh and dia of perforations		:
23.5.4	Total weight		:
23.5.5	Ref to dimensional drawing enclosed lifting arrangement		:
23.6	Description of Hardware		
23.6.1	Materials		:
23.6.2	Corrosion protection treatment		:

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)

ANNEXURE-I

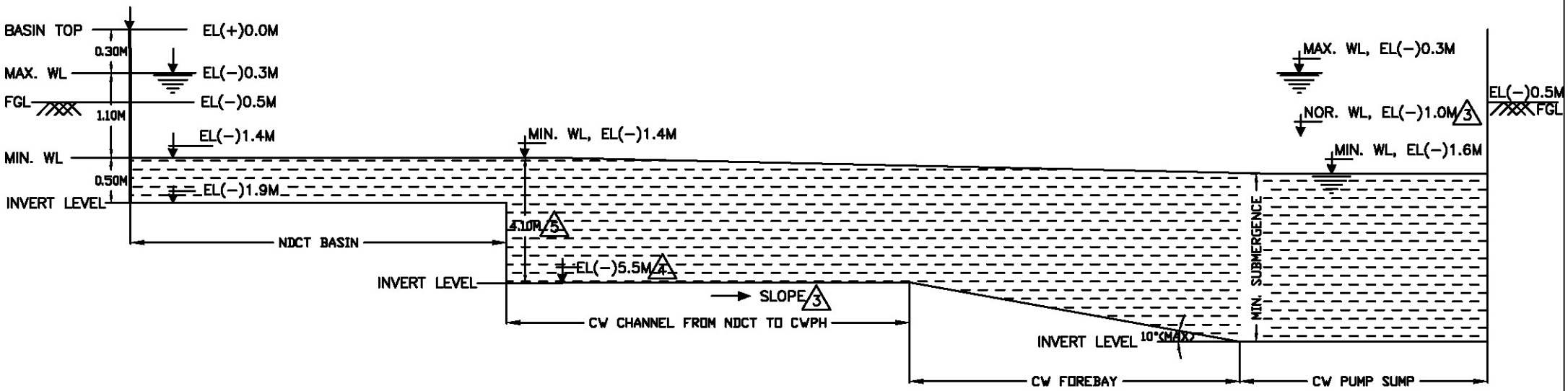
RAW WATER ANALYSIS

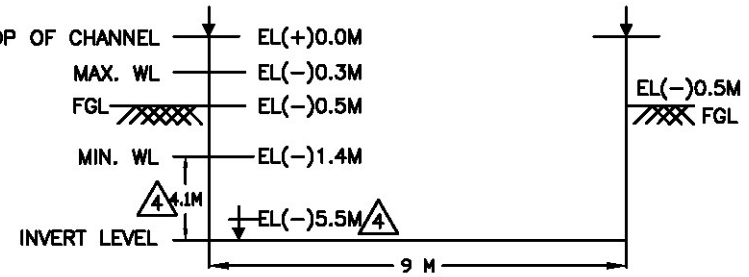
(Source – Western Yamuna Canal)

THIS IS THE APPLICABLE ANALYSIS

SL. NO.	DESCRIPTION	UNIT	PARAMETER	Filtered Water Analysis	Circulating Water Analysis
1	**Physical characteristics**				
	pH	-	8.45	8.45	8.45
	Turbidity	NTU	11 - 480	2	10
	Conductivity at 25 deg C	µmhos/cm	458.8	657.12	3285.6
	Total Dissolved solids	Mg/l	310	444	2220
	Colour	Hazen	<5.0	<5.0	<5.0
2	**Cations**				
	Calcium Hardness	mg/l	106	139.75	698.75
	Magnesium Hardness	mg/l	41	41	205
	Sodium (as Na)	mg/l	20.46	20.46	102.3
	Potassium (as K)	mg/l	7	7	35
	Iron (as Fe)	mg/l	2	0.3	1.5
3	**Anions**				
	M-alkalinity (as CaCO3)	mg/l	132	144	720
	Chlorides (as Cl)	mg/l	20.58	20.7	103.5
	Sulphate (as SO4)	mg/l	27	48.6	243
	Nitrate (as NO3)	mg/l	6.8	6.8	34
4	Total Hardness	mg/l	147	180.75	903.75
5	P-alkalinity	mg/l	3.9	3.9	19.5
6	Dissolved Silica	mg/l	6.4	6.4	32.0
7	Colloidal Silica	mg/l	4.2	4.2	21
8	Organic Matter	mg/l	4.8	4.8	24
9	Total Suspended Solids	mg/l	11 - 480	2	10

ANNEXURE-II - SKECTH INDICATING WATER LEVELS IN NDCT BASIN & CWPH



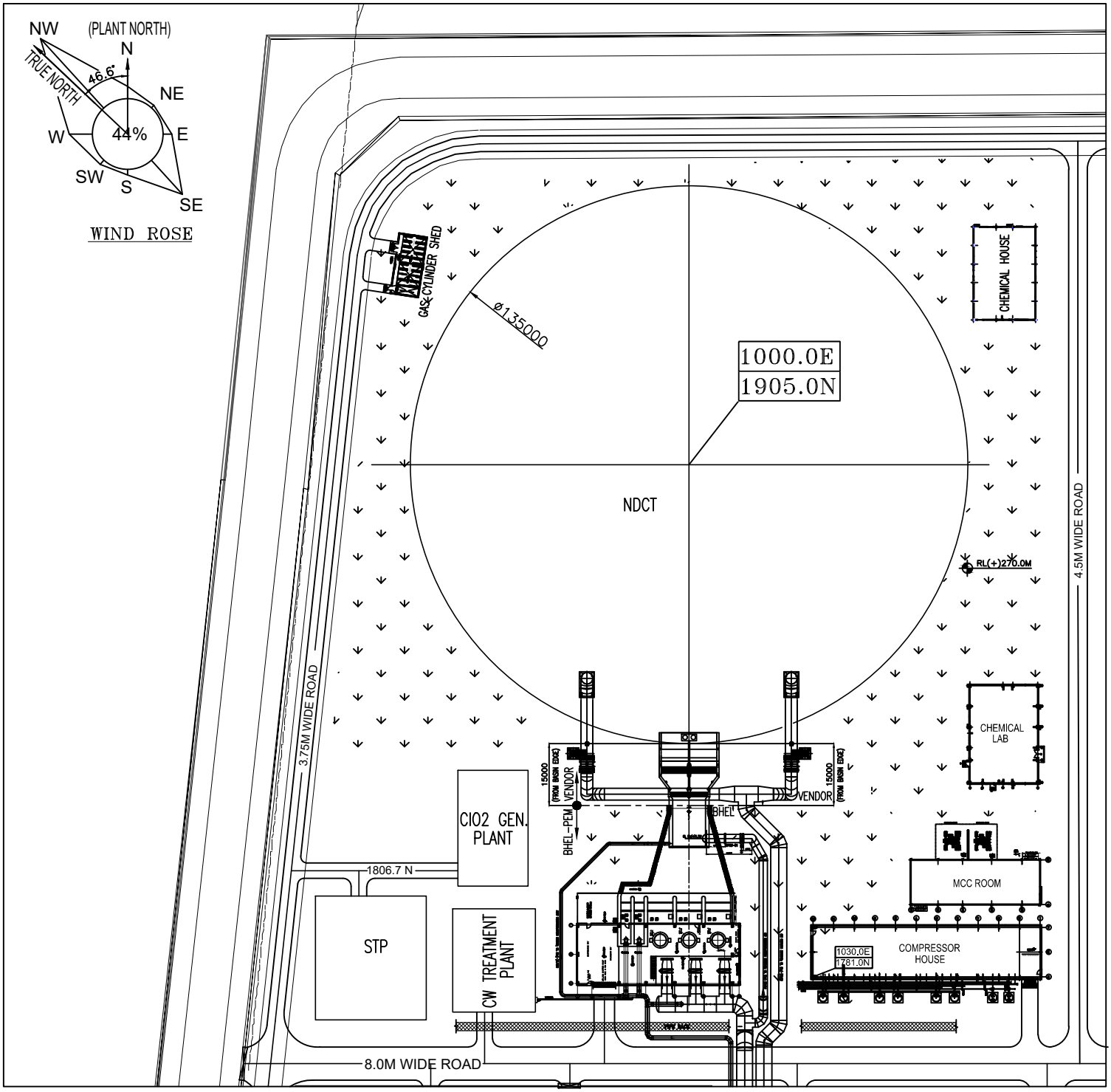


CW CHANNEL DETAILS

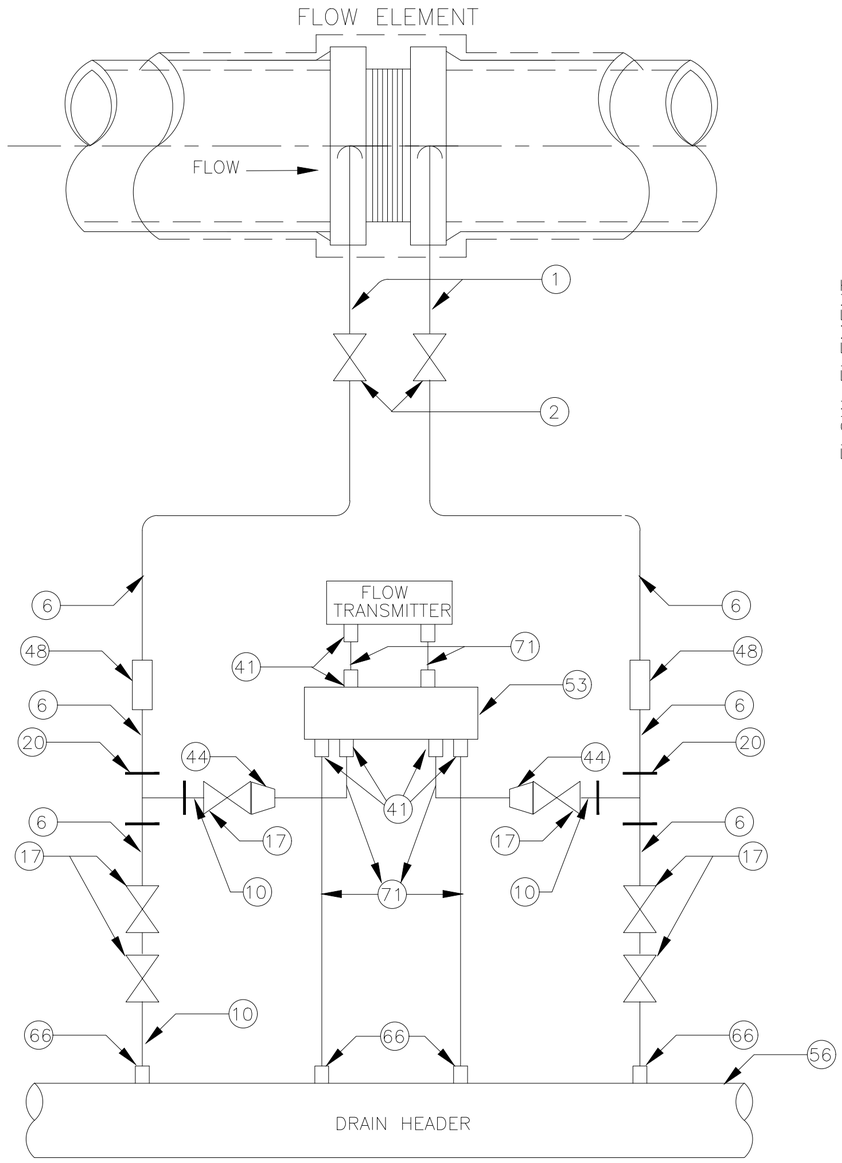
NOTE:

1. THIS SKETCH IS NOT TO SCALE.
2. MIN. SUBMERGENCE AND INVERT LEVEL OF CW SUMP, AS PER HIS, SHALL BE INDICATED IN CW PUMP GAD BY BHEL–HYD IN LINE WITH S. NO. 21 OF CRS/RESOLUTION MOM DTD 11.12.24.
3. SLOP OF CW FOREBAY SHALL BE 10 DEG (MAXIMUM) IN LINE WITH HIS.
4. WATER LEVELS OF NDCT BASIN AND CW SUMP AREA ARE INDICATED IN LINE S. NO. 4 OF CRS/RESOLUTION MOM DTD 11.12.24.
4. CHANNEL DIMENSIONS ARE INDICATED IN LINE S. NO. 4 OF CRS/RESOLUTION MOM DTD 11.12.24.

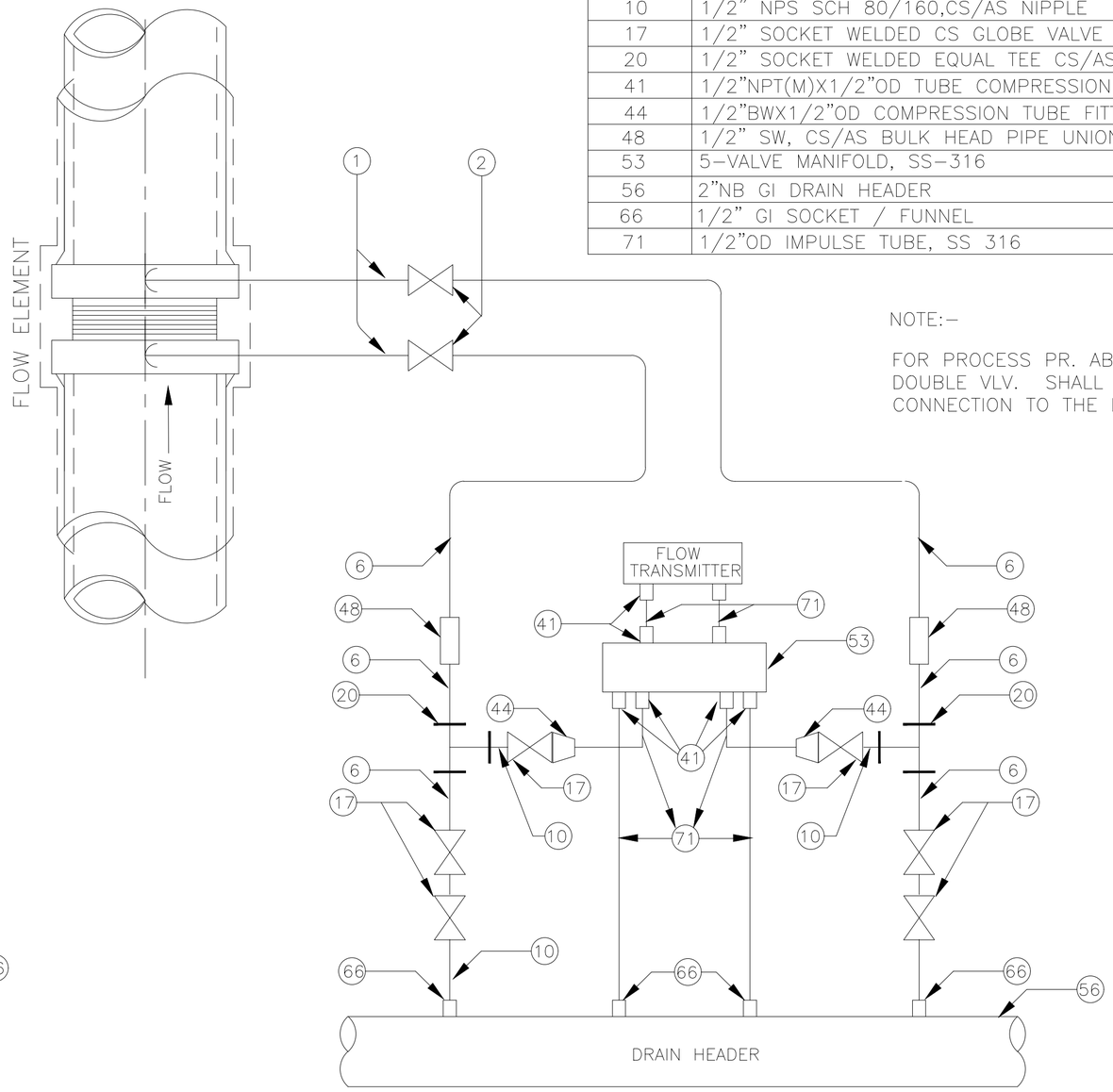
ANNEXURE–III



TAG NO.	DESCRIPTION	QTY. A	QTY. B
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.	
2	1/2" SOCKET WELDED GLOBE VALVE	2	2
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.	
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4
17	1/2" SOCKET WELDED CS GLOBE VALVE	4	4
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8	8
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2	2
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
53	5-VALVE MANIFOLD, SS-316	1	1
56	2"NB GI DRAIN HEADER	AS REQD.	
66	1/2" GI SOCKET / FUNNEL	4	4
71	1/2"OD IMPULSE TUBE, SS 316	AS REQD.	



HORIZONTAL PIPE RUN
FIG-A



VERTICAL PIPE RUN
FIG-B

NOTE:-

FOR PROCESS PR. ABOVE 40Kg/sqcm DOUBLE VLV. SHALL BE USED FOR CONNECTION TO THE DRAIN HEADER

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CONSULTANT: Desein — DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- INSTALLATION DRAWINGS FOR FLOW MEASUREMENT

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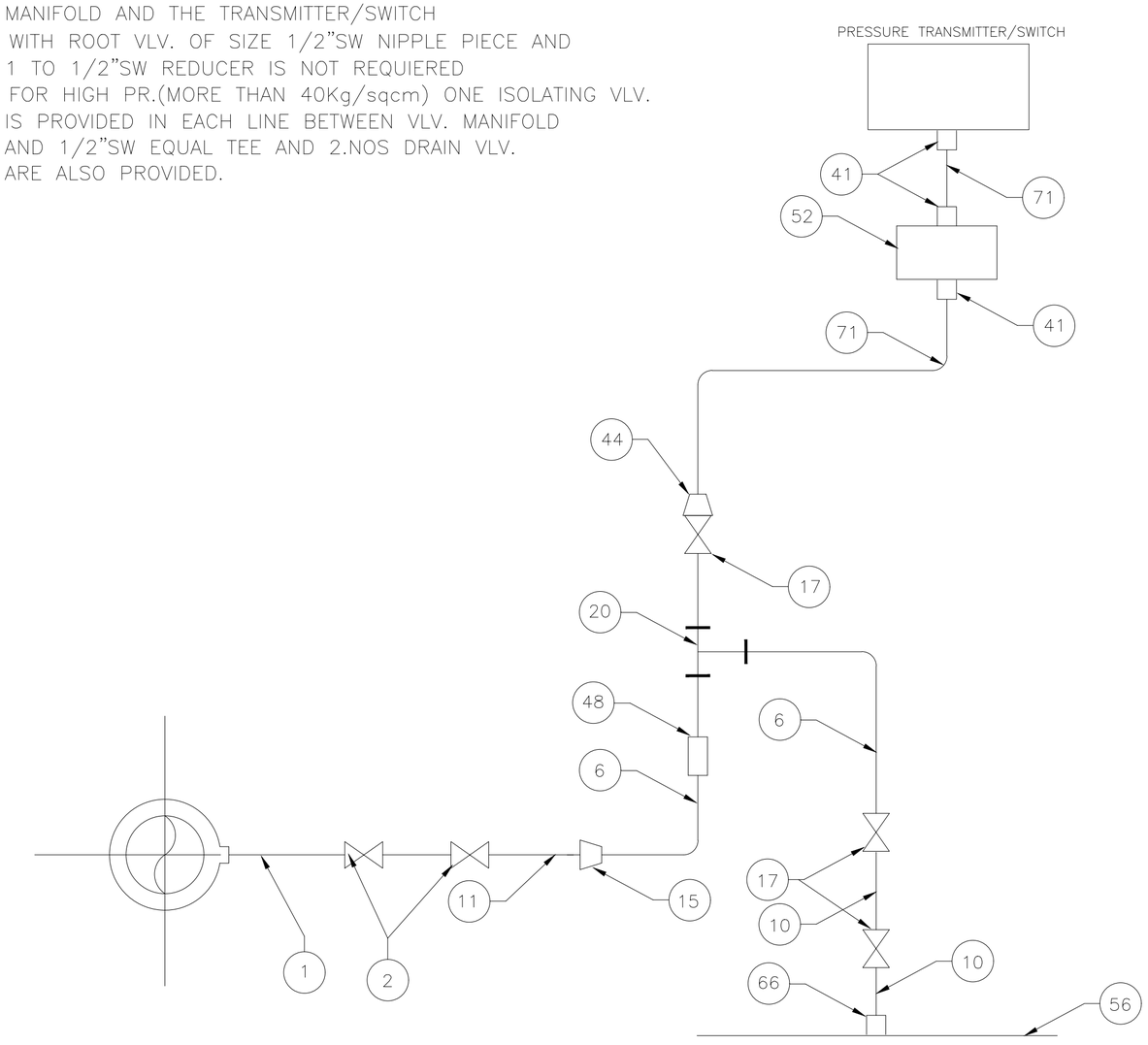
JOB. NO. D-04041

DWG. NO. 114-04-0101 — REV. O

Sheet No. 3 of 19

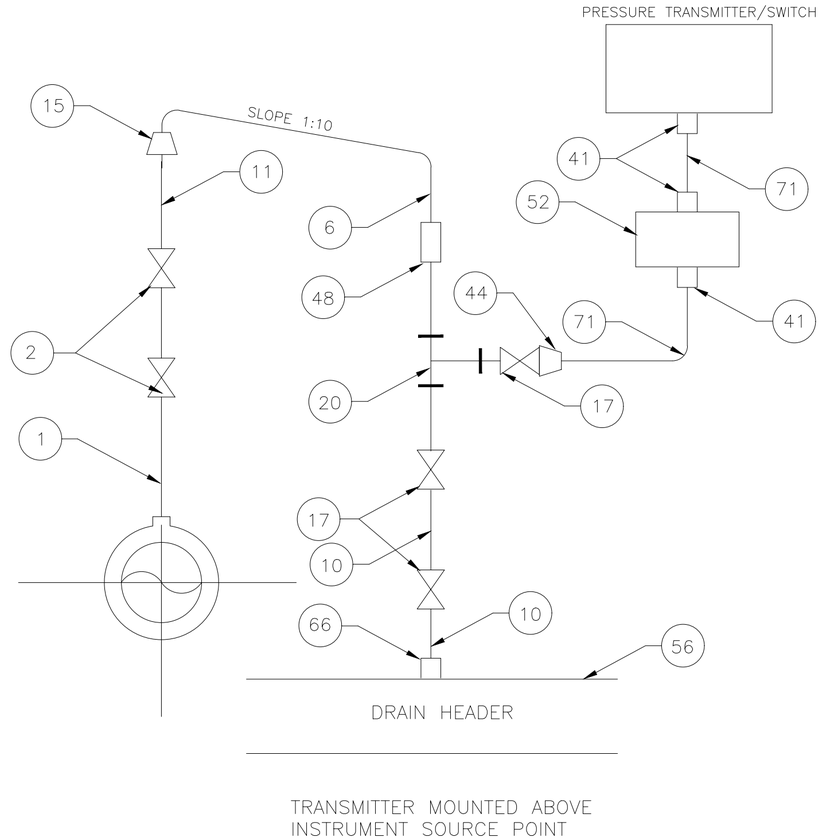
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.



TRANSMITTER MOUNTED ABOVE
INSTRUMENT SOURCE POINT

FIG–D



TRANSMITTER MOUNTED ABOVE
INSTRUMENT SOURCE POINT

FIG–C

TAG NO.	DESCRIPTION	QTY. C	QTY. D
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

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CLIENT: HPGCL — HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT — DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

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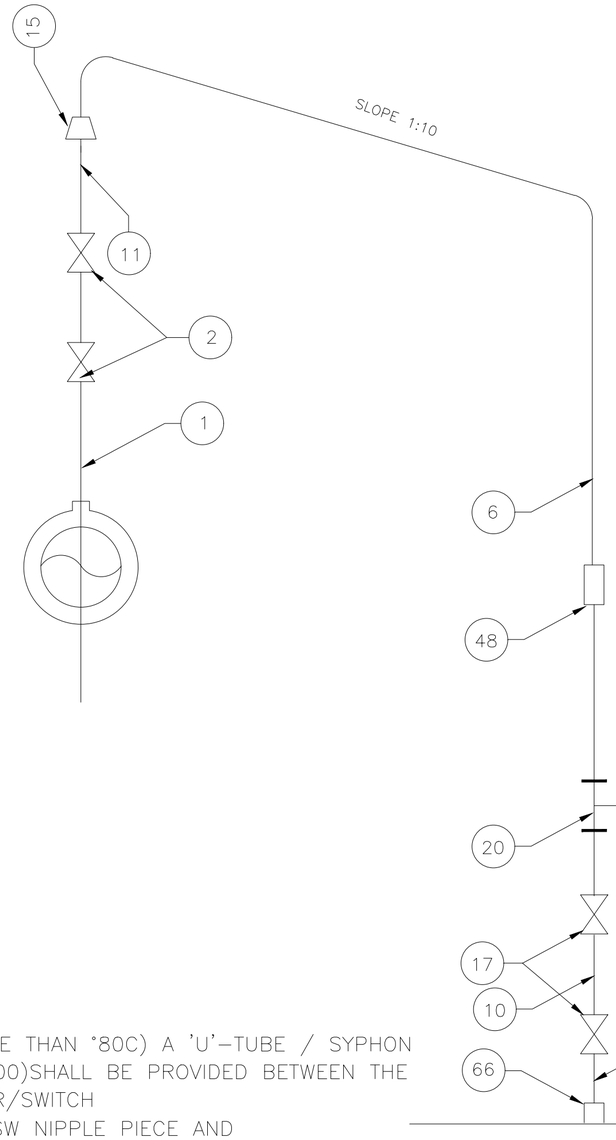
DWG. NO. 114–04–0104 — REV. O

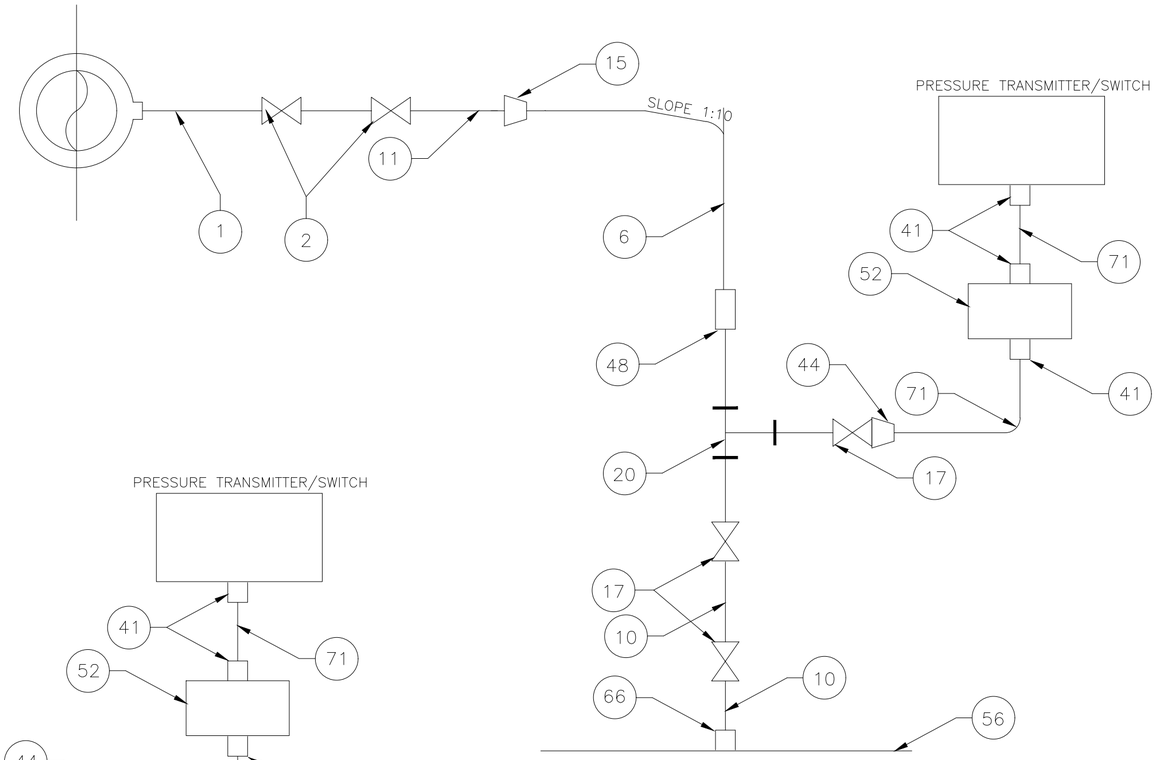
Sheet No. 7 of 19



DRAIN HEADER

TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–A



DRAIN HEADER

TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–B

NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN °80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.

BILL OF MATERIAL

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	5/3/2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"OO TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

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CONSULTANT: DESEIN — DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

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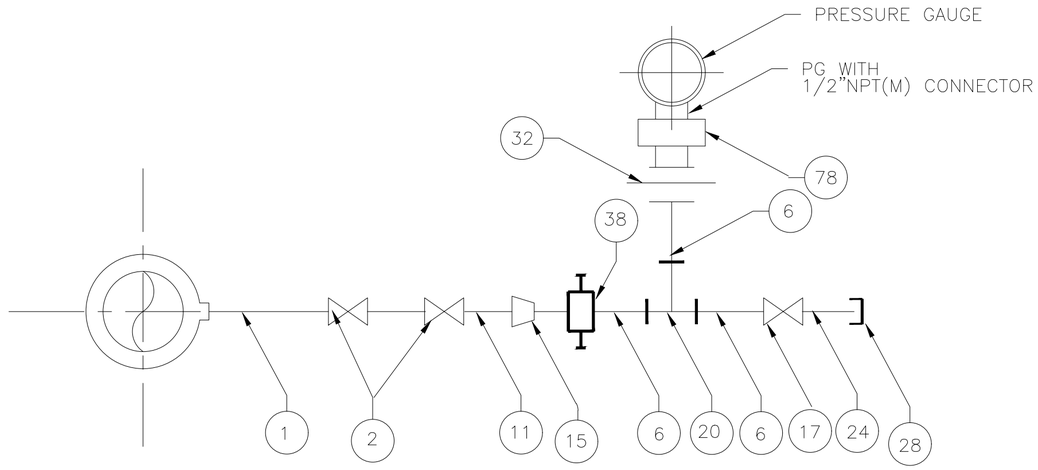
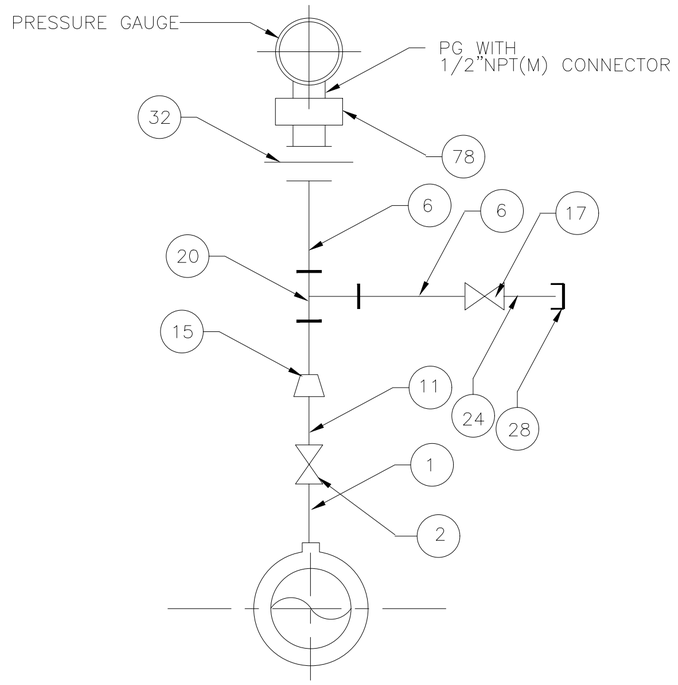
Sheet No. 6 of 19



STEAM/LIQUID SERVICE
FIG–A



AIR SERVICE
FIG–B

TAG NO.	DESCRIPTION	A QTY.	B QTY.
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/PULSATION DAMPER	1	1
59	1/2"SW, STRAIGHT PIPE CONNECTOR, CS/AS	–	–
38	3 WAY GAUGE VALVE 1/2" NB SW	1	–
37	6" COILED SYPHON SCH 80/160 1/2"NB CS/SS	–	–
32	1/2"NPS,3PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (F) CS CAP	1	1
24	1/2"NPS,SCH–80/160X1/2"NPT(M)CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	1	1
17	1/2" SW CS/AS GLOBE VALVE	1	1
15	1" TO 1/2" SOCKET WELDED REDUCER	1	1
11	1" NPS SCH–80/160 CS/AS NIPPLE	1	1
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE–SW GLOBE VALVE	2	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

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CONSULTANT: DESEIN — DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

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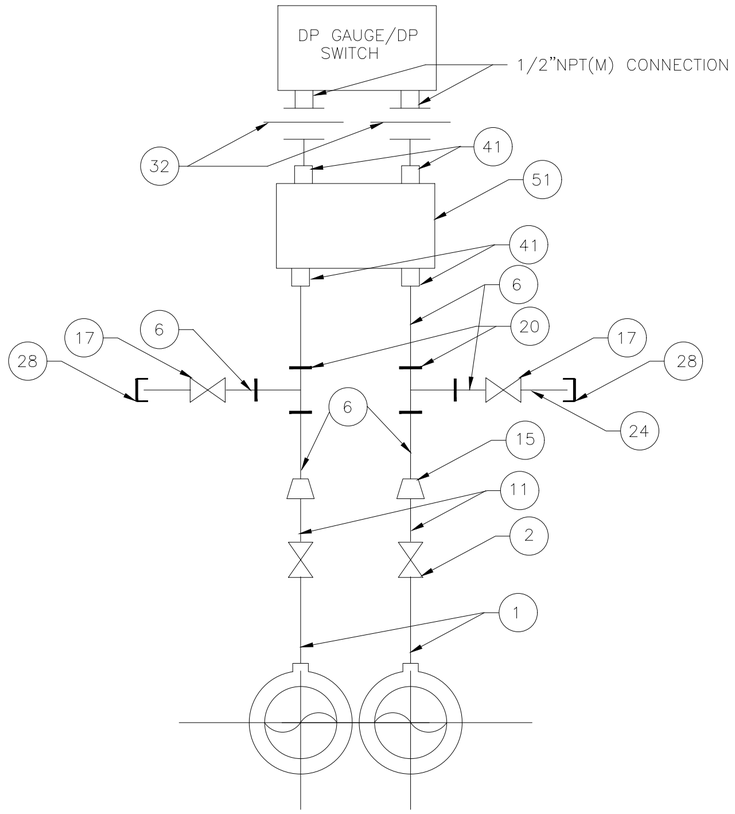
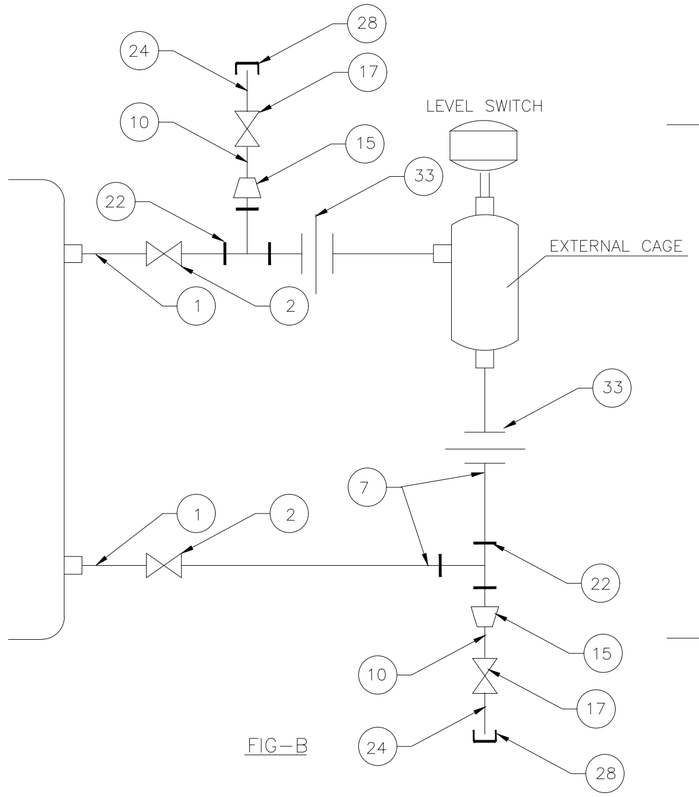
DWG. NO. 114–04–0106 — REV. O

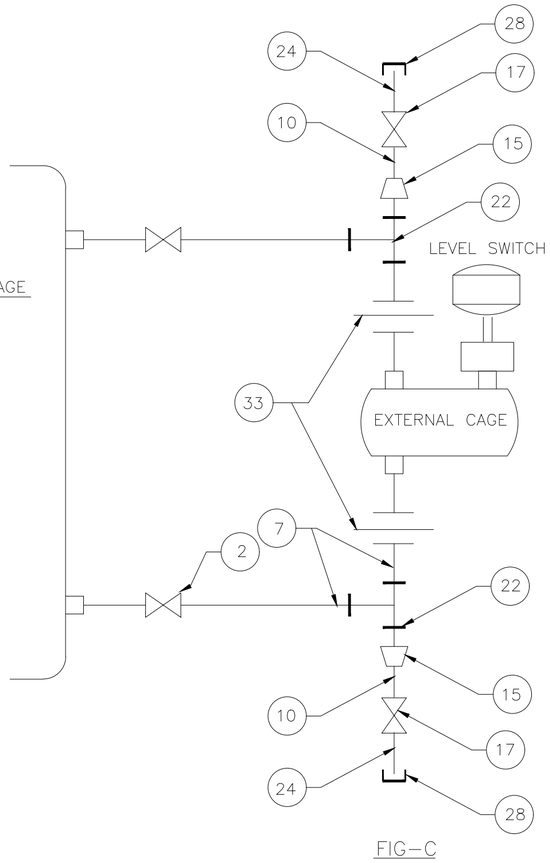
Sheet No. 9 of 19



FIG–A



FIG–B



FIG–C

78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		
TAG NO.	DESCRIPTION	A	B	C
		QTY.		

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

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TITLE :– INST. DRAWING FOR DIFF. PRESS.SWITCH/GAUGE/ LEVEL SWITCHES

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JOB. NO. D–04041

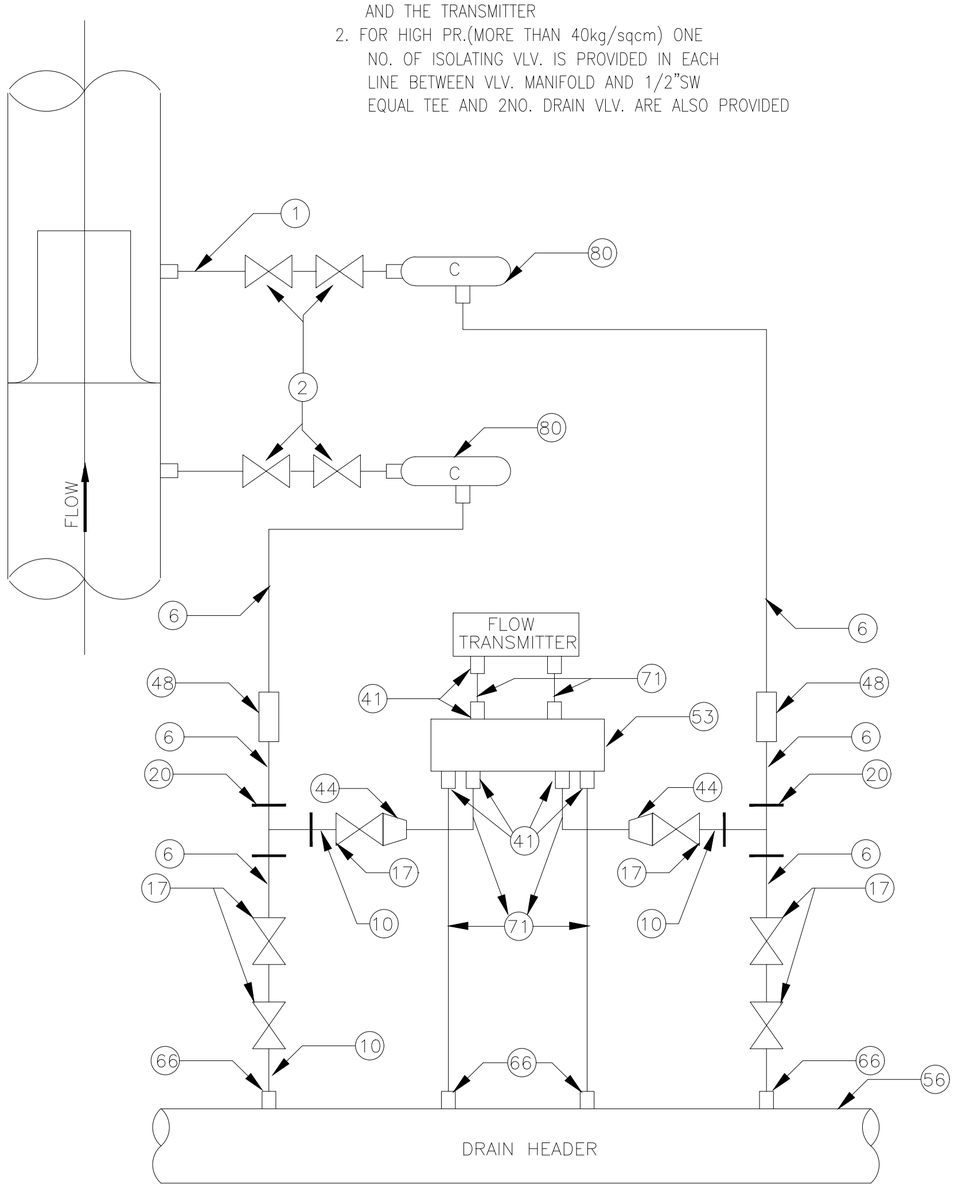
DWG. NO. 114–04–0108 — REV. O

Sheet No. 11 of 19

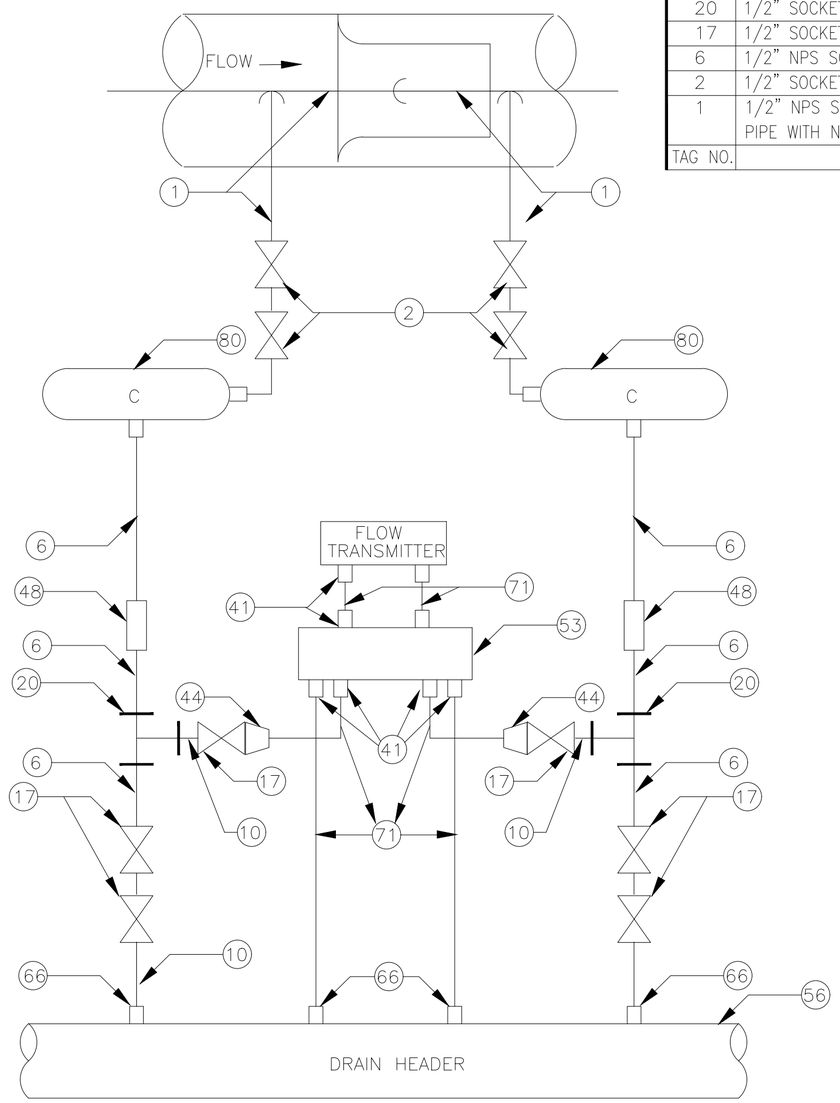
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. IN–114–04–0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO PROVIDED

TAG NO.	DESCRIPTION	A	B
80	CONDENSATION CHAMBER	2	2
71	1/2"OD IMPULSE TUBE, SS–316	AS REQD.	
66	1/2" GI SOCKET / FUNNEL	4	4
56	2"NB GI DRAIN HEADER	AS REQD.	
53	5–VALVE MANIFOLD, SS–316	1	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS–316	2	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS–316	8	8
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	6	6
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.	
2	1/2" SOCKET WELDED GLOBE VALVE	4	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.	



HORIZONTAL PIPE RUN (FIG–A)



VERTICAL PIPE RUN (FIG–B)

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REFERENCE DRAWINGS.

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APPROVED

CLIENT: HPGCL — HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :– INST. DRAWING FOR FLOW TRANSMITTERS (WATER & STEAM SERVICE)

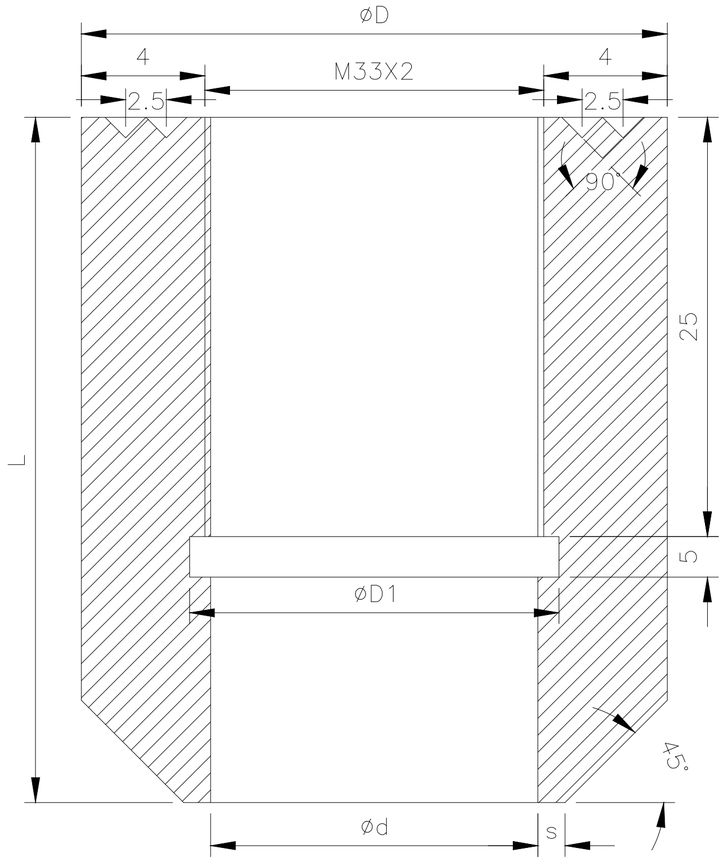
	NAME	SIGN.	DATE
CAD/DRAWN	SHIV		26.09.2022
DESIGNED	GR		26.09.2022
CHECKED	H.SUNDAR		26.09.2022

SCALE: NTS

JOB. NO. D–04041

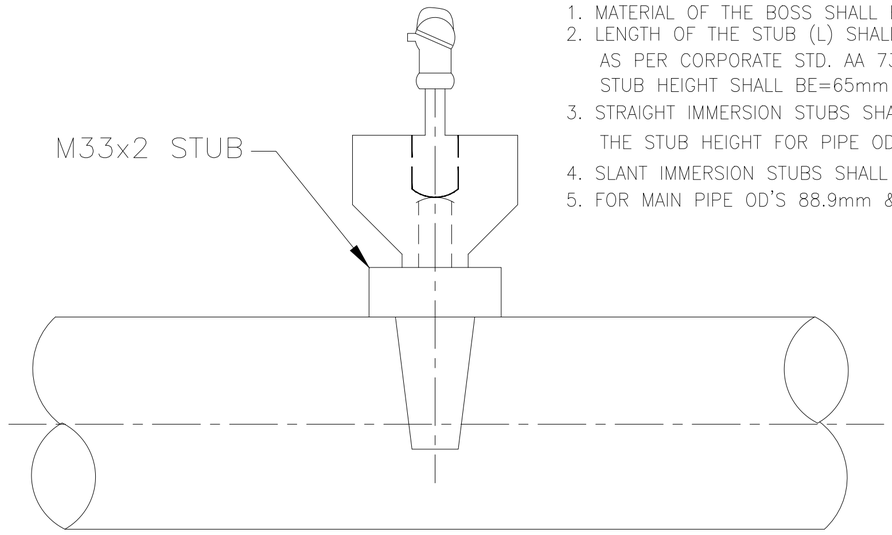
DWG. NO. 114–04–0109 — REV. O

Sheet No. 12 of 19



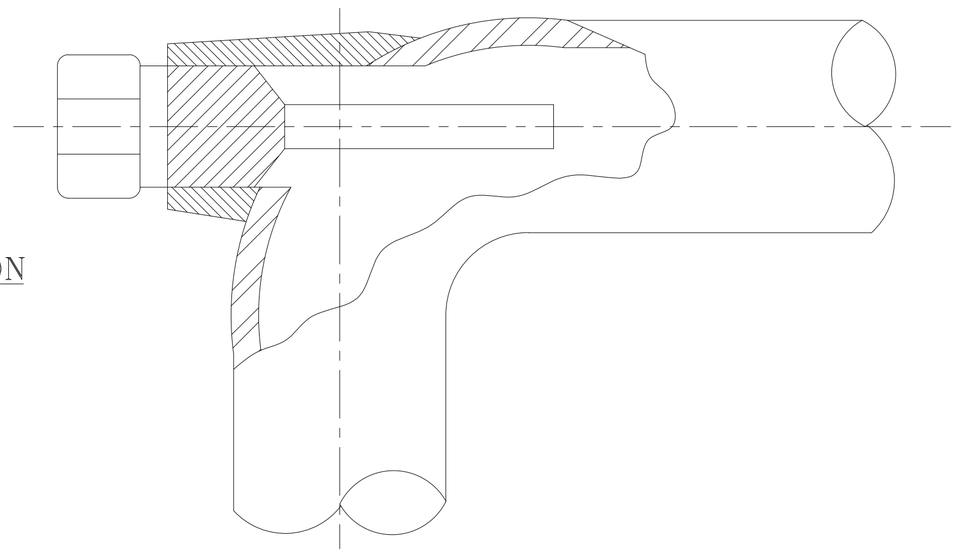
TEMPERATURE STUB FOR STRAIGHT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L



INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

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APPROVED

CLIENT: HPGCL — HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- INST. DRAWING FOR TEMPERATURE STUB

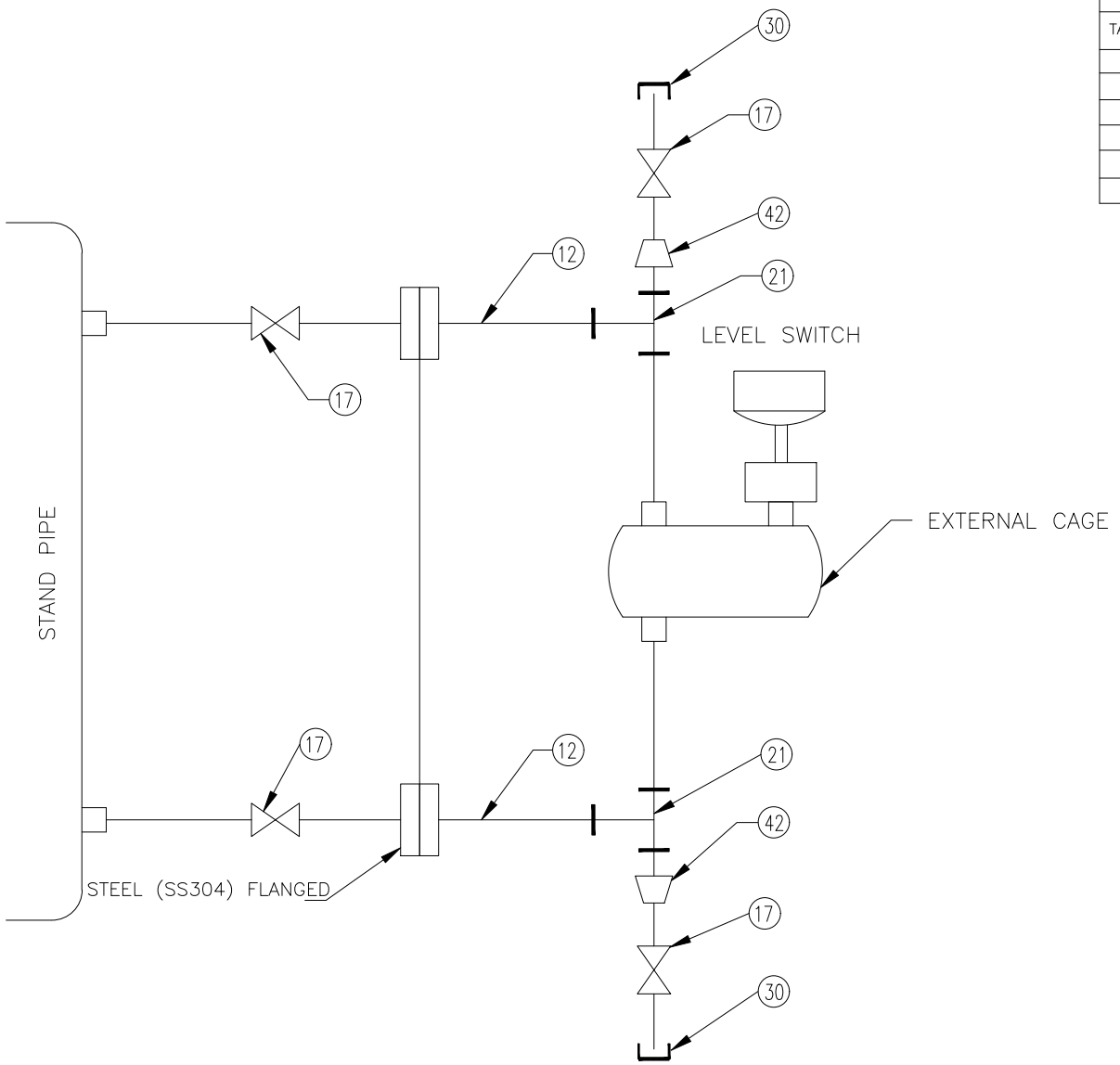
	NAME	SIGN.	DATE
CAD/DRAWN	SHIV		26.09.2022
DESIGNED	GR		26.09.2022
CHECKED	H.SUNDAR		26.09.2022
SCALE	NTS		

JOB. NO. D-04041

DWG. NO. 114-04-0111 — REV. O

Sheet No. 14 of 19

	BILL OF MATERIAL	
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



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REVISIONS — APPROVED

CLIENT: HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

	NAME	SIGN.	DATE
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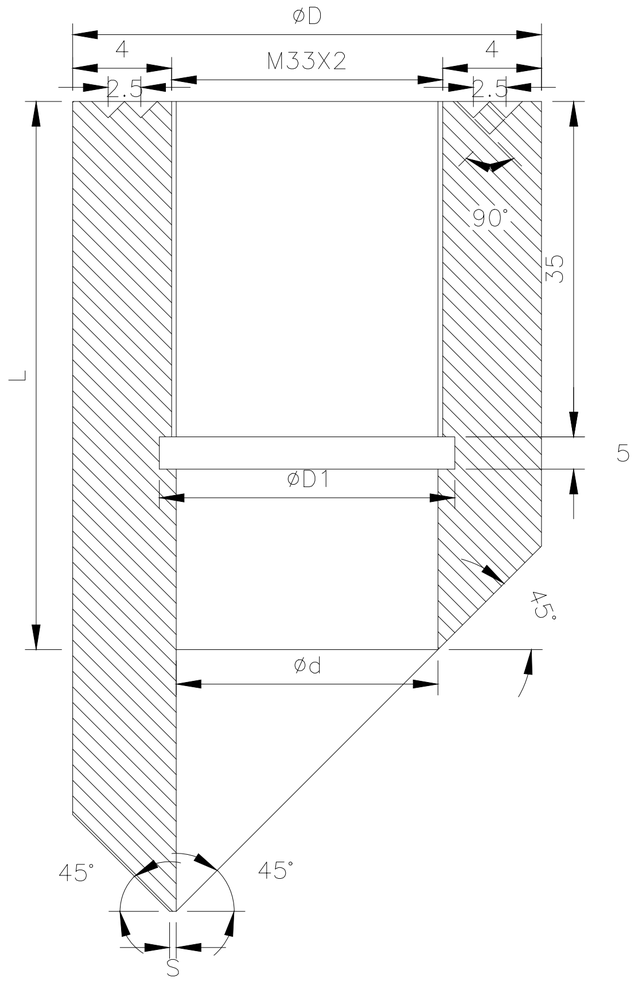
SCALE	NTS		

JOB. NO. D-04041

DWG. NO. 114-04-0113 — REV. O

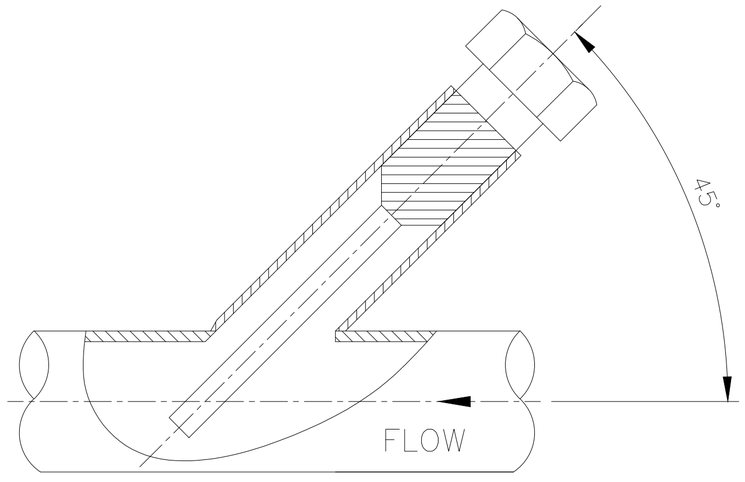


TEMPERATURE STUB FOR SLANT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

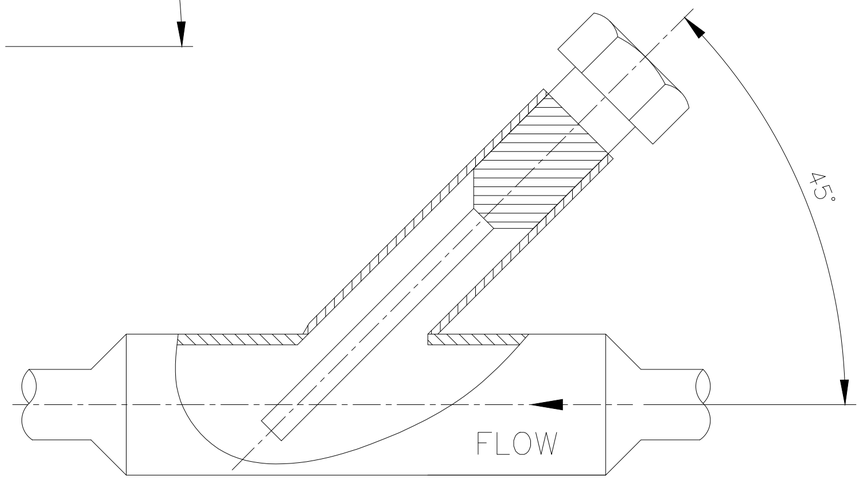
NOTE :–

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.



INSTALLATION TYPE–3

(FOR MAIN PIPE OD 88.9mm TO 159mm)



INSTALLATION TYPE–4

(FOR MAIN PIPE OD 88.9mm & BELOW)

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CLIENT: HPGCL — HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT: DESEIN — DESEIN PRIVATE LIMITED, CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :– INST. DRAWING FOR TEMPERATURE STUB

	NAME	SIGN.	DATE
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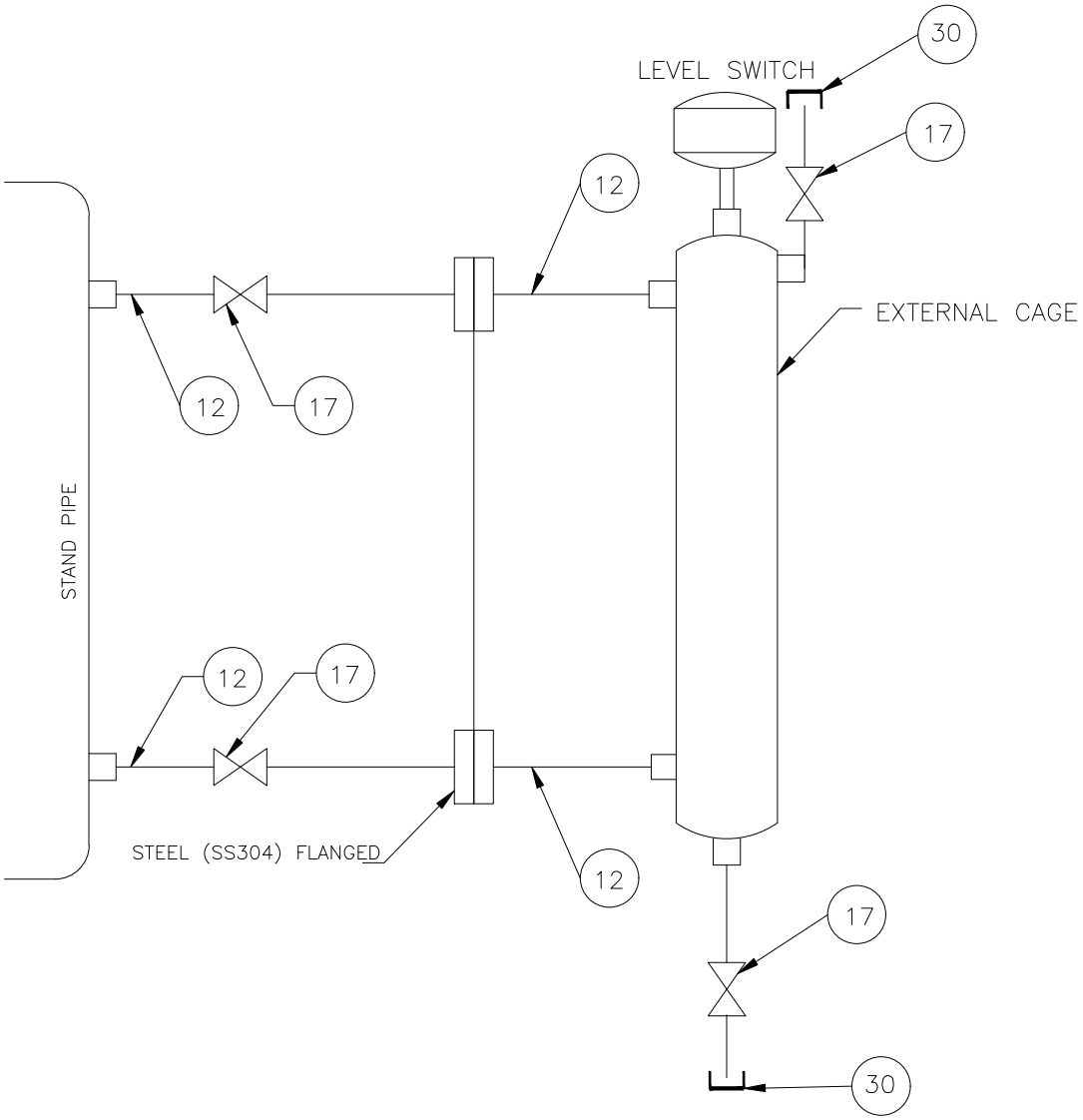
SCALE	NTS		

JOB. NO. D–04041

DWG. NO. 114–04–0115 — REV. O

Sheet No. 15 of 19

TAG NO.	BILL OF MATERIAL DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



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CONSULTANT: DESEIN PRIVATE LIMITED
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PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA
TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

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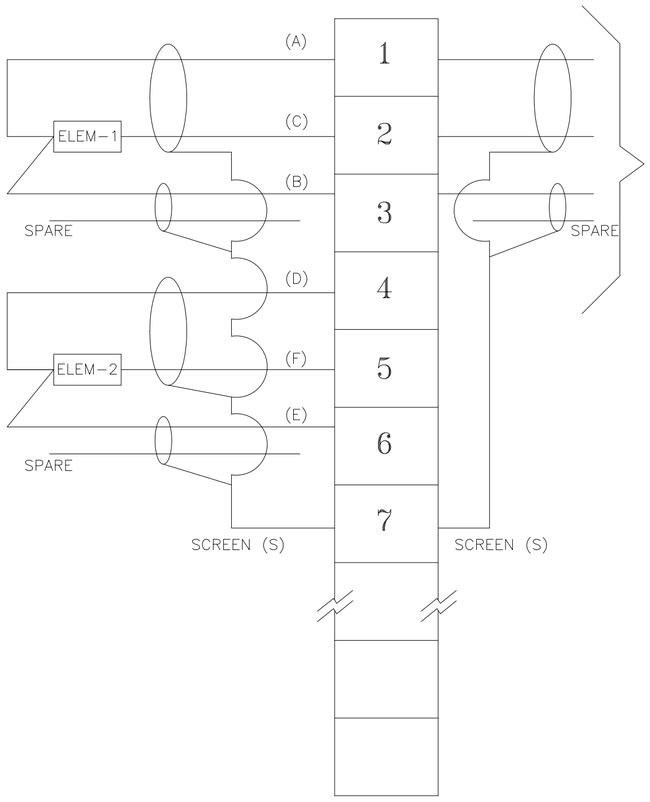
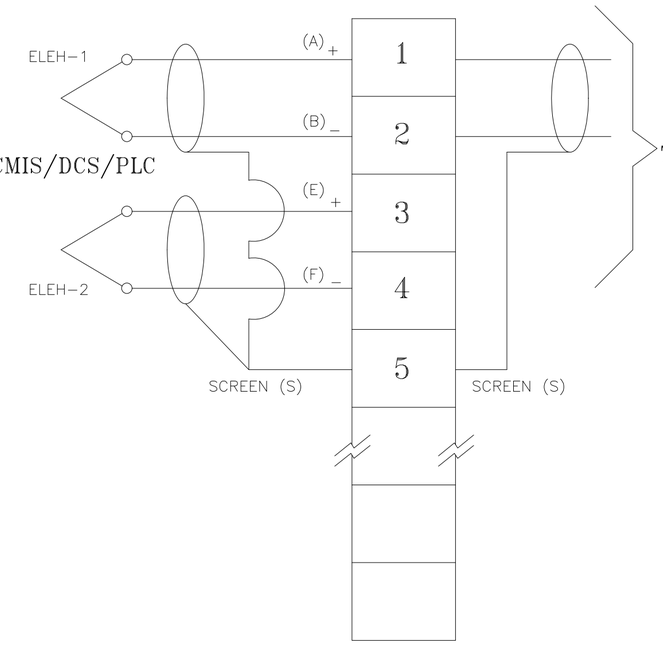
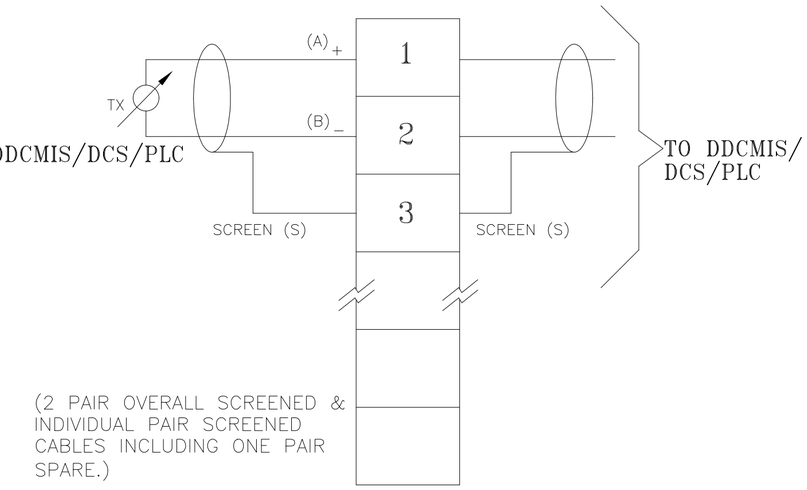
JOB. NO. D-04041
DWG. NO. 114-04-0116 REV. O



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX RTD



TYPICAL CONNECTION DIAGRAM
FOR DUPLEX THERMOCOUPLE



TYPICAL CONNECTION DIAGRAM
FOR TRANSMITTER

NOTE :-

1. SPLITTING OF CABLE MAY OCCUR WHEN TERMINALS REQD FOR AN ELEMENT ARE LOCATED ON SEPARATE STRIPS. HENCE, NO. OF TBS ON A TERMINAL STRIP SHALL BE ADDJUSTED TO PREVENT SPLITTING. 20% SPARE TB SHALL BE PROVIDED.
2. SCREENS SHALL BE EARTHED AT DDCMIS/DCS/PLC END ONLY. NO EARTHING OF SCREEN TO BE DONE AT JB/INSTRUMENT END
3. OVERALL SCREEN OF OUTGOING AND ASSOCIATED INCOMING CABLE TO BE CONNECTED TOGETHER ON A SPARE TERMINAL AND THEN CONNECTED TO EARTH AT DDCMIS/DCS/PLC END.
4. FOR SWITCH, BOTH CONTACTS (2 NO OR 2 NC AS PER PROCESS REQUIREMENT) SHALL BE CONNECTED TO JBs WITH 2 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES.
5. FOR SWITCH, ALL CONTACTS (2 NO & 2 NC) SHALL BE CONNECTED TO JBs WITH 4 PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES AS PER NIT REQUIREMENTS.

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APPROVED

CLIENT: HPGCL — HARYANA POWER GENERATION CORPORATION LTD.

CONSULTANT — DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS, NEW DELHI, INDIA

PROJECT: 1x800 MW EXPANSION UNIT DEEN BANDHU CHHOTU RAM THERMAL POWER PLANT, YAMUNA NAGAR, HARYANA

TITLE :- TYPICAL WIRING ARRANGEMENT IN JB

	NAME	SIGN.	DATE
CAD/DRAWN	SHIV		26.09.2022
DESIGNED	GR		26.09.2022
CHECKED	H.SUNDAR		26.09.2022
SCALE	NTS		

JOB. NO. D-04041

DWG. NO. 114-13-0103 — REV. O

PERFORMANCE GUARANTEES TO BE DEMOSTRATED AT SITE

1.0	**PERFORMANCE GUARANTEES:**
1.1	Bidder shall guarantee the CW Temperature for each Cooling Tower as below: The cold-water temperature of 33^0C shall be guaranteed for the design conditions of CW flow, range, ambient WBT and RH as per the performance test procedure of cooling tower elaborated elsewhere 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 Bidder. In case the "Test cold water temperature" is higher than the Predicted cold water temperature", Owner 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 cooling tower as per relevant clause & sub-section.
1.2	The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.
1.3	Performance test of Cooling Tower as per the approved test procedure for demonstration of Cold Water Temperature at design conditions shall be carried out at site. The cold water temperature as specified shall be guaranteed by the bidder for the design condition of CW flow, range, ambient wet bulb temperature specified in Technical Data Part-A.
1.4	All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.
1.5	All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Bidder shall get these instruments calibrated in an independent test Institute approved by the Owner/BHEL. All test instrumentation required for performance tests shall be supplied by the Bidder and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner/BHEL. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.
1.6	The Bidder shall submit for BHEL/Customer's approval the detailed Performance Test procedure containing the following: a) Object of the test b) Various guaranteed parameters & tests as per contract. c) Method of conductance of test and test code. d) Duration of test, frequency of readings & number of test runs. e) Method of calculation. f) Correction calculations & curves. g) Instrument list consisting of range, accuracy, least count, and location of instruments. h) Scheme showing measuring points. i) Sample calculation j) Acceptance criteria. k) Any other information required for conducting the test.
1.7	The responsibility for conducting the test lies with the Bidder.
1.8	The Performance test shall be carried out as per the agreed procedure. After the conductance of Performance test, the Bidder shall submit the test evaluation report of Performance test results to Owner/BHEL promptly but not later than one month from the date of conductance of Performance test. However, preliminary test reports shall be submitted to the Owner/BHEL after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to BHEL/Customer for approval.

1.9	Performance guarantee tests shall be carried out by the Bidder 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 permissible deviation from the design conditions as specified in this section preferably in the period from May to September.
1.10	In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Bidder 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 Owner/BHEL and re-conduct the performance guarantee test(s) with Owner's/BHEL consent. In case the specified performance guarantee(s) are still not met by the Bidder even after modification and/or replacement but are achieved within the Acceptable Shortfall Limit as specified at clause 2.0 of this chapter, Owner/BHEL will accept the equipment/system/plant after levying liquidated damages as per clause 2.0 of this chapter. However, if, the demonstrated guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications / replacements within ninety (90) days or a reasonable period allowed by the Owner/BHEL, after the tests have been completed, the Owner/BHEL will have the right to either of the following: a) Reject the equipment / system / plant and recover from the Bidder the payments already made. OR b) Accept the equipment /system/ plant after levying Liquidated Damages as indicated in clause 2.0 of this chapter shall be levied separately. The liquidated damages shall be prorated for the fractional parts of the deficiencies.
1.11	Bidder shall guarantee the **CW Pumping Head** for each Cooling Tower as below:
1.11.1	The CW Pumping head (MWC) within bidder's terminal points shall not exceed the respective maximum limits specified in Technical Data Part-A.
1.11.2	Bidder shall submit the CW pumping head calculation along with his technical offer for reference.
1.11.3	Bids with the CW pump head (MWC) more than the specified maximum limits shall not be accepted and shall be summarily rejected.
1.11.4	No advantage shall be given to any bidder for CW pumping head (MWC) offered less than specified maximum limits.
1.11.5	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.
1.11.6	The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subjected to approval.
1.11.7	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.
2.0	**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 at clause 1.1 are not met by the Bidder even after the modifications and/or replacements mentioned at clause 1.0 of this chapter, but are achieved within the stipulated Acceptable Shortfall Limit as indicated in this clause, Owner will accept the equipment/system/plant after levying liquidated damages as indicated hereunder. However, if the demonstrated guarantee(s) continue to be more than the stipulated Acceptable Shortfall Limit, the Owner may at his discretion reject the equipment/system and recover the payment already made or accept the equipment/system only after levying liquidated damages against the Bidder, at the rates listed herein, 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)	Acceptable Shortfall Limit with LD
For every 0.2^0C rise in cold water temperature stipulated in clause 1.1	112,000,000/- (INR One hundred and Twelve million only) (or equivalent foreign currency)	(+) 1^0 C of the guaranteed value

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.

PERFORMANCE GUARANTEE SCHEDULE

1	Maximum CW Pumping head permissible, viz. static head plus frictional losses as below: - Static head w.r.t. FGL (Top elevation of hot water distribution header) - Frictional losses within bidder's T.P. with 10% margin	**16**	MWC
2	Guaranteed Cold water temperature at design capacity & parameters	**33**	DegC

Signature of authorised Representative

Name and Designation :

Name & Address of the Bidder

Date

Company Seal

SUB VENDOR LIST

Shall be subject to approval during detailed engineering

1X800 MW DCRTPP YAMUNA NAGAR SUPERCRITICAL THERMAL POWER PROJECT: NATURAL DRAUGHT COOLING TOWER- LIST OF ELECTRICAL SUB VENDORS				
Sl No	**Package Name**	**Supplier Name**	**Supplier Communication Address**	**Supplier Works Address**
1	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	AM-TECH ENGG.SERVICES	Chinmay Patwardhan 305 ,UNIQUE CHAMBERS 925 B/1,FC ROAD PUNE Phone- 9822499078 Pincode : 410004 Email : amtech.aditya@amail.com	Works-1->Chinmay Patwardhan/Aditya Patwardhan Gat No. 267/A/1/1. J.N. IndustrialEstate, Pirangut -Pune-MAHARASHTRA INDIA Phone- 020-32404689 FAX : Pincode : Email : amtech.aditya@amail.com
2	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	INDUSTRIAL PERFORATION (I) PVT.LTD.	MR. A. K. SAHA 327, R.N.GUHA ROAD, DUM DUM KOLKATA Phone- 9830241788 Pincode : 700028 Email : mail@ipipl.co.in	Works-1->IMR. G. CJIAKRABORTY/MR. A. CIIAKRABORTY 327, R.N.GUHA ROAD,DUM DUM -KOLKATA-WEST BENGAL India Phone- 983093187 FAX : 033 2549 1826 Pincode : 700028 Email : mail@ipipl.co.in
3	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	Maheshwari Electrical Mfrs. Pvt. Ltd.,	Mr. Abhishek Garg, 9999902481 A-59, Sector-5, Noida, Phone- 9811027324, Pincode : 201301, Email : memindia@gmail.com,	Works-1->Mr.AMIT MAHESHWARI Dir AO-51-52,Amrit steel compound,south side G.T. Road - Ghaziabad-UTTAR PRADESH India Phone- 0120-4261611,9811465669 FAX : Pincode : 201009 Email : memindia@gmail.com,
4	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Chatterjee International Centre, 33A, Jawaharlal Nehru Road, 6th Floor, Suit No. - 11A, Kolkata, Phone- 9331008739 Pincode : 700071 Email : pppdaga4@gmail.com;info@thepremierpower.com	Works-1->Mr. C.Nayak Jalan Industrial Estate , Gate No. 1,Nr. N.H. - 6 , Village -Howrah-WEST BENGAL INDIA Phone- 9331325598 FAX : Pincode : 711411 Email : pppdaga@vsnl.com;pppdaga@airtelmail.in
5	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	MR. G.D. SINGHEE/MR. MAHESH SINGHEE 26, P.K. TAGORE STREET, MAIN BUILDING KOLKATA Phone- 9830177331 Pincode : 700006 Email : mahesh@ratans.com	Works-1-> Sankrail lndustrial Park, Bhagabatipur Mauja,Dhulagarh, -Howrah-WEST BENGAL INDIA Phone- FAX : Pincode : 711302 Email :
7	CABLE TRAYS & ACC.	ADVANCE POWER PRODUCTS LLP	Mr. Manmohan Damani 24A, Rabindra Sarani, Kolkata Phone- 033-22252463 Pincode : 700073 Email : sales@advancepowerproducts.in	Works-1-> Others 1, Lakshmanpur Industrial Area, Lakshmanpur Domjur -Howrah-WEST BENGAL INDIA Phone- 033-22252463 FAX : 033-22252464 Pincode : 711114 Email : sales@advancepowerproducts.in
8	CABLE TRAYS & ACC.	EROS METAL WORKS (P) LTD.	Mr. Amit N. Pande G-5, MIDC Industrial area Hingna Road Nagpur Phone- 9371490163 Pincode : 440028 Email : eemwpl@erosgroup.co.in;sohumpande@erosgroup.co.in	Works-1->Mr. Amit N. Pande Dir G-5, MIDC Industrial area, Hingna Road -Nagpur-MAHARASHTRA INDIA Phone- 07104-662991 FAX : 07104-232748 Pincode : 440028 Email : emwpl@erosgroup.co.in;P.head.emw@erosgroup.co.in

9	CABLE TRAYS & ACC.	INDUSTRIAL PERFORATION (I) PVT.LTD.	MR. A. K. SAHA 327, R.N.GUHA ROAD, DUM DUM KOLKATA Phone- 9830241788 Pincode : 700028 Email : mail@ipipl.co.in	Works-1->IMR. G. CJIAKRABORTY/MR. A. CIIAKRABORTY 327, R.N.GUHA ROAD,DUM DUM -KOLKATA-WEST BENGAL India Phone- 983093187 FAX : 033 2549 1826 Pincode : 700028 Email : mail@ipipl.co.in
10	CABLE TRAYS & ACC.	PARMAR METALS PVT.LTD.	MR. KIRIT PARMAR 28-A, BHAKTINAGAR INDL ESTATE RAJKOT Phone- 9925019998 Pincode : 360 002 Email : info@parmarmetal.com	
11	CABLE TRAYS & ACC.	PATNY SYSTEMS (P) LTD	PATNY PLAZA 160 , SARDAR PATEL ROAD SEUNDRABAD SECUNDRABAD Phone- 040-27902451 Pincode : 500003 Email : mr.mkt@patnysystems.com	
12	CABLE TRAYS & ACC.	PENTAX FERRO INCORPORATE	Mr. Rajeev Kandhari 801, 8th Floor, Palm Springs, Link road, Malad (W) Mumbai Phone- 09820088400 Pincode : 400064 Email : rajeev@jencogalva.com	Works-1-> Others Gut No 11/12, Opp kudus Steel rolling mill ,Taluka wada -Palghar-Maharashtra India Phone- 9820088400 FAX : Pincode : 421312 Email : pentax@jencogalva.com
13	CABLE TRAYS & ACC.	Pinax Steel Industries Pvt. Ltd.	Village - Deokuli, PO - Musepur, Bihta, Patna Phone- 9264477062 Pincode : 801103 Email : p.singh@pinaxgroup.in, kumar@pinaxgroup.in	Works-1->Vivek Karan Village - Deokuli, PO - Musepur, Bihta, -Patna-Bihar INDIA Phone- 9264431576 FAX : Pincode : 801103 Email : p.singh@pinaxgroup.in, steel@pinaxgroup.in, kumar@pinaxgroup.in, sanjay@pinaxgroup.in, tilak@pinaxgroup.in
14	CABLE TRAYS & ACC.	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Chatterjee International Centre, 33A, Jawaharlal Nehru Road, 6th Floor, Suit No. - 11A, Kolkata, Phone- 9331008739 Pincode : 700071 Email : pppdaga4@gmail.com;info@thepremierpower.com	Works-1->Mr. C.Nayak Jalan Industrial Estate , Gate No. 1,Nr. N.H. - 6 , Village -Howrah-WEST BENGAL INDIA Phone- 9331325598 FAX : Pincode : 711411 Email : pppdaga@vsnl.com;pppdaga@airtelmail.in
15	CABLE TRAYS & ACC.	R.K. Engineering Works	W/87,Addl Ambernath Anandnagar,MIDC,Ambernath-East Thane Phone- 9923009696 Pincode : 421506 Email : salespune@rkenggwork	Works-1->K.S. Mhoparekar, Proprietor W/87,Addl Ambernath, Anandnagar,MIDC,Ambernath-East -Thane-MAHARASHTRA INDIA Phone- 9923009696 FAX : 0251-2620960 Pincode : 421506 Email : salespune@rkenggworks.in
16	CABLE TRAYS & ACC.	RABI ENGINEERING WORKS PVT. LTD.	MR. TAPAN KUMAR SEN/MR. SIDDHARTHA 327, R.N. GUHA ROAD, DUM DUM, KOLKATA Phone- 9748753002 Pincode : 700028 Email : rabiengineering@gmail.com	Works-1->MR. SIDDHARTHA ADHIKARY 327 , R.N.GUHA ROAD, DUM DUM -KOLKATA-WEST BENGAL INDIA Phone- 9748753002 FAX : 033-25497024 Pincode : 700028 Email : rabiengineering@gmail.com

17	CABLE TRAYS & ACC.	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	MR. G.D. SINGHEE/MR. MAHESH SINGHEE 26, P.K. TAGORE STREET, MAIN BUILDING KOLKATA Phone- 9830177331 Pincode : 700006 Email : mahesh@ratans.com	Works-1-> Sankrail Industrial Park, Bhagabatipur Mauja,Dhulagarh, -Howrah-WEST BENGAL INDIA Phone- FAX : Pincode : 711302 Email :
18	CABLE TRAYS & ACC.	RUKMANI ELECTRICAL & COMPONENTS PVT LTD	11A , MAHARISHI DEBENDRA ROAD 1ST FL , ROOM NO.4 KOLKATA Phone- Pincode : 700007 Email : maruthikabra@gmail.com	Works-1->Maruthi Kabra Village : Kharial, P.O : Dankuni Coal Co, Dist : Hooghly, -Kolkata-WEST BENGAL INDIA Phone- 9330255908 FAX : 033-26590251 Pincode : 712 310 Email : maruthikabra@gmail.com Works-2->+Maruthi Kabra Urla Industrial Area, Urla Sarora Road, -Raipur-CHATTISGARH INDIA Phone- 0771-325 0889 FAX : 033-26590251 Pincode : 493 221 Email : maruthikabra@gmail.com Works-3->+Rukmani Fab&Gal Pvt. Ltd., Shankaridaha, Baniyarah,Jalan Ind. Complex, Gate No. 3, -Domjur, Howrah-WEST BENGAL INDIA Phone- 9330255908 FAX : 033-26590251 Pincode : 711411 Email : rukmanimva@yahoo.co.in
19	CABLE TRAYS & ACC.	Saral Industries	Mr. Y.K. Gupta L-1, L-2, Industrial Area-1 Sultanpur Road Rae Bareli Phone- 0535-2702474 Pincode : 229010 Email : saralindustries@gmail.com	Works-1->Mr. Y.K. Gupta Others L-1, L-2, Industrial Area-1, Sultanpur Road -Rae Bareli-UTTAR PRADESH INDIA Phone- 0535-2702474 FAX : 0535-2702473 Pincode : 229010 Email : saralindustries@gmail.com
20	CABLE TRAYS & ACC.	UNITECH FABRICATORS and ENGINEERS PVT LTD	INDRAPRASHTHA APARTMENT 24 , M.B.RAOD , BIRATI KALABAGAN KOLKATA KOLKATA Phone- 9836381647 Pincode : 700051 Email : ufepl@rediffmail.com;ufepl@vsnl.net;	Works-1->KAMAL KUMAR BHATTACHARJEE NH-6, BOMBAY ROAD, KONA-CHAMRAIL, -HOWRAH-WEST BENGAL INDIA Phone- 9831 1 79391 FAX : 03212-246428 Pincode : 711 114 Email : ufepl@rediffmail.com
21	LT XLPE POWER CABLE	Advance Cable Technologies (P) Ltd.	Mr. Siddharth Jain G-1, Sunrise Serenity, No.1,40 Ft.Road, M.R. Garden,Geddalahhalli, Aswathnagar, Bangalore Phone- 9845326881 Pincode : 560094 Email : dbhat@advancecable.in	Works-1->Siddharth Jain Dir Pl.No.10&14,Survey No95. KIADB Ind. area, Doddaballapur, -Bengaluru-KARNATAKA INDIA Phone- 9845028973 FAX : Pincode : 561203 Email : siddharth@advancecable.in
22	LT XLPE POWER CABLE	APAR INDUSTRIES LTD.	Mr. Vijay Kumar Bajaj 12/13,Jyoti Wire House,23-A,Shah Ind Est Off. Veera Desai Road, Andheri (West). Mumbai Phone- 022-26740001 Pincode : 400053 Email : info.cable@apar.com	Works-1-> Plot No-158-163 & 153, G.I.D.C. Umbergaon,Dist-Valsad, -Vadodara-GUJARAT India Phone- 0260-2562412 FAX : 0260-2562950 Pincode : 396171, Email : works@uniflex.in

23	LT XLPE POWER CABLE	Axelon Industries	3050, 51, 52 and 3054 GIDC Phase 3, Dared Jamnagar Phone- 9867769603 Pincode : 361005 Email : hardik@axeloninternational.com	
24	LT XLPE POWER CABLE	CHANDRESH CABLES LIMITED	Mr RK JAIN/MD, G-6 NEW MADHAVPURA MARKET, NEAR POLICE COMMI. OFFICE, SHAHIBAUG AHMEDABAD Phone- 9825136231 Pincode : 380004 Email : rkjain@avocab.com	Works-1->Mr.Abhishek Jain Dir BLOCK 1108 VILLAGE:CHHATRAL,TAL: KALOL - GANDHINAGAR-GUJARAT INDIA Phone- 79-25623055,9825136231 FAX : Pincode : 382729 Email : rkjain@avocab.com;abhishek@avocab.com;tender@avocab.com
25	LT XLPE POWER CABLE	CORDS CABLE INDUSTRIES LTD.	MR. NAVEEN SAWHNEY B-1/A-26, MOHAN CO-OPERATIVE INDUSTRIAL ESTATE, MATHURA ROAD, NEW DELHI Phone- 9818356799 Pincode : 110044 Email : sg@cordscable.com	Works-1->MR. DINESH SHUKLA A - 525 & E - 519, INDUSTRIAL AREA,CHOPANKI, -BHIWADI DIST. ALWAR-RAJASTHAN INDIA Phone- 08769138881 FAX : Pincode : 301 019, Email : dinesh.shukla@cordscable.com
26	LT XLPE POWER CABLE	Dynamic Cables Limited	F-260 ,Road No. 13 V.K.I Area Jaipur Phone- 01412332388 Pincode : 302013 Email : info@dynamiccables.co.in	Works-1->Mr. Ashish Mangal Dir H-581(A)-592(A), Road No. 06, V.K.I Area -Jaipur-RAJASTHAN INDIA Phone- 01412332388,9001096020 FAX : Pincode : 302013 Email : info@dynamiccables.co.in,ashish@dynamiccables.co.in;kadam@dynamiccables.co.in Works-2->+Mr. Ashish Mangal Dir F-260, Road no. 13, V.K.I Area -Jaipur-RAJASTHAN INDIA Phone- 01412332388,9001096020 FAX : Pincode : 3022013 Email : info@dynamiccables.co.in,ashish@dynamiccables.co.in;kadam@dynamiccables.co.in
27	LT XLPE POWER CABLE	GEMSCAB INDUSTRIES LTD.	Sh. A. N. Pathak, (GM/Business Develop.) 704-707, 7th Floor, Vikrant Tower 4, Rajendra Place NEW DELHI Phone- 09212560974 Pincode : 110008 Email : anpathak@gemscab.com	Works-1->Mr. S.K. Gupta SP-1192/L&K, Phase-IV,RIICO Industrial Area,Bhiwadi -Alwar-RAJASTHAN INDIA Phone- 09214330530 FAX : 01493 - 222752 Pincode : 301 019 Email : rktyagi@gemscab.com
28	LT XLPE POWER CABLE	GUPTA POWER INFRASTRUCTURE LIMITED	Mr. NITISH KUMAR PARIDA ,502, 5th Floor, K M Trade Tower,Radisson Blu Complex, Sector-14, Kaushambi Ghaziabad Phone- 09861995978 Pincode : 201010 Email : info@guptapower.com	Works-1-> Others Plot No. F/9 & F/16, IID Centre, Khurda --Odisha INDIA Phone- 06742313898, 9861966777 FAX : 06742312083 Pincode : 752054 Email : gorav@guptapower.com

29	LT XLPE POWER CABLE	Insucon Cables And Conductors Pvt. Ltd.	Mr. SUMIT NAHATA, 314-A, 3rd Floor, City Centre, Sansar Chand Road Jaipur Phone- 8290073333 Pincode : 302001 Email : info@insuconcables.com	Works-1->Mr. SUMIT NAHATA Others F-61,62,63 Road no 5A, Bindayaka industrial Area -JAIPUR-RAJASTHAN INDIA Phone- 8290073333 FAX : Pincode : 301041 Email : info@insuconcables.com
30	LT XLPE POWER CABLE	KEI INDUSTRIES LTD.	Mr. ANIL GUPTA D-90, OKHLA INDUSTRIAL AREA, PHASE-I, NEW DELHI Phone- 011-26818840 Pincode : 110020 Email : lalit.saxena@kei-ind.com	Works-1->Mr. K.C SHARMA/ Mr. N.S. YADAV SP-919/920/922 RIICO INDUSTRIAL AREA,PHASE-III, BHIWADI -ALWAR-RAJASTHAN INDIA Phone- 9828588561 FAX : 01493-221731 Pincode : 301019 Email : lalit.saxena@kei-ind.com
31	LT XLPE POWER CABLE	Lumino Industries Limited	Acropolis, 1858/1, 12th Floor, Rajdanga Main Road, KOLKATA Phone- 9711480487 Pincode : 700107 Email : northzone@luminoindustries.com	Works-1-> Biprannapara, Jalan Complex, PS: Domjur, -Howrah,-WEST BENGAL INDIA Phone- 9674758844 FAX : Pincode : 711411 Email : vishnu@luminoindustries.com
32	LT XLPE POWER CABLE	Nangalwala Industries Pvt. Ltd.	F 151 to 154 M.I.A M.I.A Alwar Phone- 9928033029 Pincode : 301030 Email : registration@suncables.co	Works-1->Madhur Agarwal Others F 151 to 154 M.I.A, -Alwar-RAJASTHAN INDIA Phone- 9928033029 FAX : Pincode : 301030 Email : madhur.agarwal@suncables.co
33	LT XLPE POWER CABLE	POLYCAB INDIA LIMITED	HICO HOUSE, Ist FLOOR, 771, PANDIT SATWALEKAR MARG, MAHIM, MUMBAI Phone- 011-29841697 Pincode : 400016 Email : lnsingh@polycab.com	Works-1->Mr. V. P. Pandey 74/10-11, Village Kadaiya, Daman Industrial Area -Daman-DAMAN & DIU INDIA Phone- 011-29841697 FAX : Pincode : Email : lnsingh@polycab.com
34	LT XLPE POWER CABLE	Ravi Industries	Deepak Goyal, Proprietor Plot No. 451,EPIP,HSIIDC INDUSTRIAL AREA Sec-53, Phase 3, Kundli Sonipat Phone- 9810019276 Pincode : 131028 Email : deepakgoyal@deegeelitecables.com	Works-1->Deepak Goyal, Proprietor,Plot No. 451 Others EPIP, HSIIDC INDUSTRIAL AREA, Sec-53, Phase 3, Kundli -Sonipat-HARYANA INDIA Phone- 9810019276 FAX : Pincode : 131028 Email : deepakgoyal@deegeelitecables.com
35	LT XLPE POWER CABLE	SBEE CABLES (INDIA) LIMITED	Kishore Kumar .B, Director No.29, JCW Industrial Estate 11th Km Kanakapura Road Bangalore Phone- 08026662172 Pincode : 560062 Email : info@sbeecables.in	Works-1-> No.29,JCW Industrial Estate 11th Km,Kanakapura Road -Bangalore-KARNATAKA INDIA Phone- 08026662172 FAX : Pincode : 560062 Email : info@sbeecables.in

36	LT XLPE POWER CABLE	SPECIAL CABLES PVT. LTD.	MR.MUKUL KHANNA-VICE PRESIDENT B-II/12, Mohan Cooperative Industrial estate, Badarpur, Mathura Road NEW DELHI Phone-9599186479 Pincode : 110044 Email : sales@specialcables.co.in	Works-1->Mr.Mukul Khanna /Mr. Manoj Kumar B-II/12, Badarpur,Mohan Cooperative Industrial Estates -NEW DELHI-DELHI INDIA Phone-9599186479,9311255781 FAX : 011-29891011 Pincode : 110044 Email : sales1@specialcables.co.in;mkhanna@specialcables.co.in Works-2->+MR. RAHUL KHANNA/MR. SANDEEP VERMA Plot No. 60-65, Sector-3, I.I.E. Sidcul, Pantnagar, -Rudrapur (U.S. Nagar),-UTTRAKHAND INDIA Phone-9811092281 FAX : 011-26428153 Pincode : 263153 Email : sales@specialcables.co.in
37	LT XLPE POWER CABLE	SRIRAM CABLES PVT. LTD.	Anil Garg / Sunil Garg Flat No. 102, A 8A Rama Road, Adarsh Nagar Delhi Phone- 011-27670005 Pincode : 110033 Email : contact@sriramcables.com	Works-1->Satish Garg/ Arvind Kumar A-524, RIICO Industrial Area,Chopanki, Bhiwadi -Alwar-RAJASTHAN India Phone-9910074449 FAX : 011-27671598 Pincode : 301707 Email : arvind@sriramcables.com
38	LT XLPE POWER CABLE	SUYOG ELECTRICALS LTD.	Mr.Bimal Y.Desai/Mr. Haresh Hansoti 1, Madhuvan Apartment,24 Arunoday Society,Alkapuri VADODARA Phone-9227192737 Pincode : 390 007 Email : suyog@seplcables.com	Works-1->Mr.Bimal Y.Desai/Mr. Toshal Y. Desai A/2, 2205 & C1-2204, -Halol-GUJARAT INDIA Phone-0265-2311665 FAX : 0265-2339160 Pincode : Email : suyog@seplcables.com
39	LT XLPE POWER CABLE	THERMO CABLES LTD.	Ms.UMA GHURKA/N.SRINIVASA RAO 28, NAGARJUNA HILLS, PUNJAGUTTA HYDERABAD Phone-9397803596 Pincode : 500082 Email : isharma@thermocables.com	Works-1->SIDDARTHA SIRDESHPANDE D-48&49,Phase-V,IDA,JEEDIMETLA -HYDERABAD-TELANGANA INDIA Phone-9396649886 FAX : 040-23090661 Pincode : 500 0855 Email : sss@thermocables.com
40	LT XLPE POWER CABLE	TIRUPATI PLASTOMATICS PVT. LTD.	Mr. Ravi Gemini B-141 A, Road No. 9D V.K.I. Area Jaipur Phone-0141-2330305 Pincode : 302013 Email : ravi.gemini@yahoo.com	Works-1->Mr. Ravi Gemini Dir B-141 A, Road No. 9D, V.K.I. Area -Jaipur-RAJASTHAN INDIA Phone-0141-2330305 FAX : 0141-2260073 Pincode : 302013 Email : ravi.gemini@yahoo.com
41	LT XLPE POWER CABLE	V-MARC INDIA LIMITED	Mr. Vikas Garg, 203,Aditya Complex,Local Shopping Centre Sarita Vihar 110092 Phone-8171169401 Pincode : New Delhi Email : sales@v-marc.in	Works-1->Mr. Vikas Garg Dir Plot No-3, Sector - IIDC, IIE SIDCUL -Haridwar-UTTRAKHAND INDIA Phone- 8171169401 FAX : 0133-4239644 Pincode : 249403 Email : sales@v-marc.in

42	LT XLPE POWER CABLE	Zenium Cables Ltd.	H.O:102/103 Leena Heights,Opp.Thunga Hospital Mira Bhayander Road, Mira Road(E) Thane Phone- 02228114444 Pincode : 401107 Email : info@zeniumcables.com	Works-1->Mr. Amit L. Goti,Survey No.342/1/1/1P, Dir Lal Darwaja,Udwada Paria Road,Vill.Sarodhi,Tal. PARADI, -Valsad-GUJARAT INDIA Phone- 02602994975,9323456104 FAX : Pincode : 396185 Email : amit@zeniumcables.com
43	ABOVE GROUND EARTHING MATERIALS	ADVANCE POWER PRODUCTS LLP	Mr. Manmohan Damani 24A, Rabindra Sarani, Kolkata Phone- 033-22252463 Pincode : 700073 Email : sales@advancepowerproducts.in	Works-1->Mr. Shrutika Mohta Others Lakshmanpur Industrial Area, Lakshmanpur Domjur -Howrah-WEST BENGAL INDIA Phone- 033-6290750612 FAX : Pincode : 711114 Email : sales@advancepowerproducts.in
44	ABOVE GROUND EARTHING MATERIALS	AVAIDS TECHNOVATORS PVT. LTD.	Shri Rajesh Piplani 4A/58, Shankar Road NEW DELHI Phone- 9910481854 Pincode : 110060 Email : rajendra@avaids.biz,papandev@avaids.biz	Works-1->Mr Krishan Kalra DGM 131, Matsya Industrial Area -Alwar-RAJASTHAN INDIA Phone- 9958096168 FAX : Pincode : 301001 Email : engineering@avaids.biz
45	ABOVE GROUND EARTHING MATERIALS	EROS INFRASTRUCTURES PVT. LTD.	Mr. Amit Pande MIDC Industrial Area, Butibori, G-97, Nagpur Phone- 0712-3205305 Pincode : 441103 Email : amitp@erosgroup.co.in	Works-1-> MIDC Industrial Area, Butibori, G-97, -Nagpur-MAHARASHTRA INDIA Phone- 0712-3205305 FAX : 0712-2734474 Pincode : 441103 Email : chippa@erosgroup.co.in
46	ABOVE GROUND EARTHING MATERIALS	Hobb Internatinal Pvt Ltd	P.s. Pace 10th Floor Suite no 1001 1/1A Mahendra Roy Lane KOLKATA Phone- 9830079313 Pincode : 700046 Email : vedant@hobbinternational.com	
47	ABOVE GROUND EARTHING MATERIALS	INDIA ELECTRICALS SYNDICATE	Mr. Suresh Kumar Agarwal 55, Ezra Street, Mo. 9038668684 Kolkata Phone- 033-22354047 Pincode : 700001 Email : cabletray@cabletray.net	Works-1->Mr. Suresh Kumar Agarwal (W) 80, Jawpore Road, -Kolkata-WEST BENGAL India Phone- 033-22354047 FAX : 033-22154005 Pincode : 700074 Email : cabletray@cabletray.net ;info@cabletray.net Works-2->+Mr. Anjan Agarwal Jangalpur, Jalan Industrial Complex, -Howrah-WEST BENGAL India Phone- 033-22354047 FAX : 033-22154005 Pincode : 711411 Email : cabletray@cabletray.net
48	ABOVE GROUND EARTHING MATERIALS	INDUSTRIAL PERFORATION (I) PVT.LTD.	MR. A. K. SAHA 327, R.N.GUHA ROAD, DUM DUM KOLKATA Phone- 9830241788 Pincode : 700028 Email : mail@ipipl.co.in	Works-1->IMR. G. CJIAKRABORTY/MR. A. CIIAKRABORTY 327, R.N.GUHA ROAD,DUM DUM -KOLKATA-WEST BENGAL India Phone- 983093187 FAX : 033 2549 1826 Pincode : 700028 Email : mail@ipipl.co.in
49	ABOVE GROUND EARTHING MATERIALS	NAMDHARI INDUSTRIAL TRADERS PVT. LTD	Mr. Gurdeep Singh 515/5, Industrial Area-B, Overlock Road, Ludhiana Phone- 0161-2531398 Pincode : 141003 Email : namdhari_ind_traders@yahoo.com	Works-1->Mr. Gurdeep Singh, Dir , Village Latton Dana, Chandigarh Road, -Ludhiana-PUNJAB INDIA Phone- 01612531398 FAX : 01612535171 Pincode : 141003 Email : namdhari_ind_traders@yahoo.com

50	ABOVE GROUND EARTHING MATERIALS	PATNY SYSTEMS (P) LTD	PATNY PLAZA 160 , SARDAR PATEL ROAD SEUNDRABAD SECUNDRABAD Phone- 040-27902451 Pincode : 500003 Email : mr.mkt@patnysystems.com	Works-1- >MR.SURESH/MR.SESIBHUSHAN 9/A, S.V.C.I.E, BALANAGAR, -HYDERABAD-TELANGANA INDIA Phone- 040-27902451 FAX : 040-27902451 Pincode : Email : info@patnysystems.com
51	ABOVE GROUND EARTHING MATERIALS	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Chatterjee International Centre, 33A, Jawaharlal Nehru Road, 6th Floor, Suit No. - 11A, Kolkata, Phone- 9331008739 Pincode : 700071 Email : pppdaga4@gmail.com;info@thepremierpower.com	Works-1->Mr. C.Nayak Jalan Industrial Estate , Gate No. 1,Nr. N.H. - 6 , Village -Howrah-WEST BENGAL INDIA Phone- 9331325598 FAX : Pincode : 711411 Email : pppdaga@vsnl.com;pppdaga@airtelmail.in
52	ABOVE GROUND EARTHING MATERIALS	RABI ENGINEERING WORKS PVT. LTD.	MR. TAPAN KUMAR SEN/MR. SIDDHARTHA 327, R.N. GUHA ROAD, DUM DUM, KOLKATA Phone- 9748753002 Pincode : 700028 Email : rabiengineering@gmail.com	
53	ABOVE GROUND EARTHING MATERIALS	RAJASTHAN METAL SMELTING CO.	D-80, Road No. 7, V.K.I.A., Jaipur Phone- 9928966443 Pincode : 302013 Email : info@rmscoindia.com	Works-1-> Others D-80, Road No. 7, V.K.I.A., -Jaipur-RAJASTHAN INDIA Phone- FAX : Pincode : 302013 Email : info@rmscoindia.com
54	ABOVE GROUND EARTHING MATERIALS	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	MR. G.D. SINGHEE/MR. MAHESH SINGHEE 26, P.K. TAGORE STREET, MAIN BUILDING KOLKATA Phone- 9830177331 Pincode : 700006 Email : mahesh@ratans.com	Works-1-> Sankrail lndustrial Park, Bhagabatipur Mauja,Dhulagarh, -Howrah-WEST BENGAL INDIA Phone- FAX : Pincode : 711302 Email :
55	ABOVE GROUND EARTHING MATERIALS	RUKMANI ELECTRICAL & COMPONENTS PVT LTD	11A , MAHARISHI DEBENDRA ROAD 1ST FL , ROOM NO.4 KOLKATA Phone- Pincode : 700007 Email : maruthikabra@gmail.com	Works-1->Maruthi Kabra Village : Kharial, P.O : Dankuni Coal Co, Dist : Hooghly, -Kolkata-WEST BENGAL INDIA Phone- 9330255908 FAX : 033-26590251 Pincode : 712 310 Email : maruthikabra@gmail.com Works-2->+Maruthi Kabra Urla Industrial Area, Urla Sarora Road, -Raipur-CHATTISGARH INDIA Phone- 0771-325 0889 FAX : 033-26590251 Pincode : 493 221 Email : maruthikabra@gmail.com Works-3->+Rukmani Fab&Gal Pvt. Ltd., Shankaridaha, Baniyarah,Jalan Ind. Complex, Gate No. 3, -Domjur, Howrah-WEST BENGAL INDIA Phone- 9330255908 FAX : 033-26590251 Pincode : 711411 Email : rukmanimva@yahoo.co.in

56	ABOVE GROUND EARTHING MATERIALS	Saral Industries	Mr. Y.K. Gupta L-1, L-2, Industrial Area-1 Sultanpur Road Rae Bareli Phone- 0535-2702474 Pincode : 229010 Email : saralindustries@gmail.com	Works-1->Mr. Y.K. Gupta Others L-1, L-2, Industrial Area-1, Sultanpur Road -Rae Bareli-UTTAR PRADESH INDIA Phone- 0535-2702474 FAX : 0535-2702473 Pincode : 229010 Email : saralindustries@gmail.com
57	ABOVE GROUND EARTHING MATERIALS	UNITECH FABRICATORS and ENGINEERS PVT LTD	INDRAPRASHTHA APARTMENT 24 , M.B.RAOD , BIRATI KALABAGAN KOLKATA KOLKATA Phone- 9836381647 Pincode : 700051 Email : ufepl@rediffmail.com;ufepl@vsnl.net;	Works-1->KAMAL KUMAR BHATTACHARJEE NH-6, BOMBAY ROAD, KONA-CHAMRAIL, -HOWRAH-WEST BENGAL INDIA Phone- 9831 1 79391 FAX : 03212-246428 Pincode : 711 114 Email : ufepl@rediffmail.com
58	DISTRIBUTION BOARDS	AVAIDS TECHNOVATORS PVT. LTD.	Shri Rajesh Piplani 4A/58, Shankar Road NEW DELHI Phone- 9910481854 Pincode : 110060 Email : rajendra@avaids.biz,papandey@avaids.biz	Works-1->Mr. Rajesh Piplani CEO 131, MIA -Alwar-RAJASTHAN INDIA Phone- 9810007076 FAX : Pincode : 301030 Email : rajesh@avaids.biz Works-2->+Mr. Rajesh Piplani CEO 184A-185, Manesar -Gurgaon-HARYANA INDIA Phone- 9810007076 FAX : Pincode : 122050 Email : rajesh@avaids.biz
59	DISTRIBUTION BOARDS	HULASI METALS PVT. LTD.	F-111,112, kartarpura Industrial area Road number 4, next to Parnami complex 22 Godam, near Bank of Baroda Jaipur Phone- 9314503083 Pincode : 302006 Email : abaid@hulasi.co.in	Works-1->ABHISHEK BAID,F-111,112 kartarpura Industrial area, Dir Road number 4, 22 Godam, near Bank of Baroda -Jaipur-RAJASTHAN INDIA Phone- FAX : Pincode : 302006 Email : 9314503083
60	DISTRIBUTION BOARDS	Milestones Switchgears Pvt. Ltd.	97, Udyog Vihar Phase-1 Gurgaon Phone- 9871384554 Pincode : 122016 Email : panel@milestonesindia.com;ashok@milestonesindia.com	Works-1->Ashok Kumar Sharma DGM 97, Udyog Vihar, Phase-1 -GURUGRAM-HARYANA INDIA Phone- FAX : Pincode : 122016 Email : ashok@milestonesindia.com
61	DISTRIBUTION BOARDS	NITYA ELECTROCONTROLS PVT. LTD.	Mr. H.S. Panchal , C-47,SECTOR - 81, Phase-II, Noida Phone- 0120-4057600 Pincode : 201305 Email : hspanchal@nityaelectricals.com	Works-1->Mr. H.S. Panchal , CEO C-47,SECTOR - 81,Phase-II -Noida-UTTAR PRADESH India Phone- 0120-4057600,8744007905 FAX : Pincode : 201305 Email : enquiry@nityaelectricals.com
62	DISTRIBUTION BOARDS	Sanhit Automation Technologies Pvt. Ltd.	Mr. Hitesh Sharma Plot No. 510/467 Sector 37, Pacecity II Gurgaon Phone- 9810320675 Pincode : 122001 Email : hs@sanhitgroup.com	Works-1->Mr. Hitesh Sharma Dir Plot No. G418, Road No.22, Sector 25,RIICO Industrial Area -Bhiwadi-RAJASTHAN INDIA Phone- 9810320675 FAX : 01244034468 Pincode : 301019 Email : hs@sanhitgroup.com
63	DISTRIBUTION BOARDS	Ultima Switchgears Limited	Mr. Vansh Parmar B-3, Basement DDA Local Shopping Complex New Delhi Phone- 9582221901 Pincode : 110091 Email : vdp@ultimaswitchgear.com	Works-1->Ms. Nikita Parmar,Khasra No. 215, Others Industrial Area,, Village Raipur, Tehsil Roorkee -Roorkee-UTTARANCHAL India Phone- 7290061155 FAX : Pincode : 247667 Email : nikita@ultimaswitchgear.com;info@ultimaswitchgear.com

64	LIGHTING FIXTURES (LED)	Neev Luminaries	B-6/3 Okhla Industrial Area | Phase-2| New Delhi | 110020	Phone: 011 40604830-31, M:8826995888 Fax: +91 11 4060 4831 info@neevenergy.in, Jitendra Sahu <jsahu@neevenergy.com>
65	LIGHTING FIXTURES (LED)	HAVELLS INDIA LIMITED	QRG TOWERS , 2D SECTOR-126, NOIDA-201301	GIRISH KUMAR SHRIVASTAVA +91-9810528922, girish.srivastava@havells.com\
66	LIGHTING FIXTURES (LED)	BAJAJ ELECTRICALS	BAJAJ ELECTRICALS LTD. ENGINEERING & PROJECTS BU (NORTH) 3rd FLOOR, GULMOHARHOUSE, COMMUNITY CENTRE 161/B-4, GAUTAM NAGAR, YUSUF SARAI NEW DELHI – 110049	CONTACT PERSON : Mr. S. SREEMANY. SR. MANAGER (PROJECTS) CONTACT DETAILS : (+91) 9871025705. MAIL ID : srabans@bajajelectricals.com;
67	LIGHTING FIXTURES (LED)	SURYA ROSHNI LIMITED	1	011-25810093 ; 9810071832 (Akhilesh Agrawal) aagrawal@sroshni.com
68	LIGHTING FIXTURES (LED)	PHILIPS	9TH FLOOR,DLF 9B, DLF CYBER CITY, DLF PHASE-III,GURGAON-122002	01244606001, Sharad (+919871150447), Mr. Guruseelan M 8939693949, Mr Ashish Sethi 9007077089
69	LIGHTING FIXTURES (LED)	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	mohitsharma@hplindia.com, Mr. Nitesh Verma 8851036938, Mr Ajay lakra 9560045423
70	LIGHTING FIXTURES (LED)	INSTA POWER	PLOT NO. - 457 PHASE - V, UDYOG VIHAR, GURGAON - 122016	124-4124000, Mr amit Bhardwar: 8800508090
71	LIGHTING FIXTURES (LED)	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 Udaipur -313003, Rajasthan,	Concern Person – Mr. Praveen sisodiya : 9314310042(psisodia@pyrotechlighting.com) Ms Ritika 9509245814
72	LIGHTING FIXTURES (LED)	M/s Halonix Technologies Limited	M/s Halonix Technologies Limited B-31 , Phase –II, Noida Distt. Gautam Budh Nagar (U.P.) Pin- 201305	Mr. Mohit Gautam ' 'Tel: +919568152111 'mohit.gautam@halonix.co.in'; M: 9891868793'rahul.singh@halonix.co.in'

73	LIGHTING FIXTURES (LED)	M/s JAQUAR & COMPANY PVT. LTD.	M/s JAQUAR & COMPANY PVT. LTD. Plot No.3 , Sector M-11, IMT Manesar. Gurgaon· 122050 Haryana	Mr. Dhruv Kumar ' 'Tel: +919350043727 dhruv.kumar@jaquar.com ; gaurav.bhalla@jaquar.com : 9582950282
74	LIGHTING FIXTURES (LED)	M/s CROMPTON GREAVES CONSUMER ELECTRICALS LTD.	M/s CROMPTON GREAVES CONSUMER ELECTRICALS LTD.Tower-3, 1st Floor, East Wing Equinox Business Park LBS Marg, Kurla (West), Mumbai-400070	Mr S L Sivakumar 'Sivakumar L' <sivakumar.sl@crompton.co.in> M: 9176609363
75	LIGHTING FIXTURES (LED)	M/s WIPRO ENTERPRISES PRIVATE LTD.	M/s WIPRO ENTERPRISES PRIVATE LTD. L-8, MIDC Waluj, Aurangabad-431136, Maharashtra, India	Ms Dhanya K K 'dhanya.kk8@wipro.com' M 9891815476, Mr Puneet kalia 'puneet.kalia@wipro.com'
76	LIGHTING FIXTURES (LED)	M/s Nessa Illumination Technologies Pvt. Ltd.	M/s Nessa Illumination Technologies Pvt. Ltd.36/A Devraj Industrial Park, Opp. Sameep Fabrics, Pipalaj Pirana Road, Piplaj, Ahmedabad	Mr. Dhaval Shah <dhaval@nessa.in> M 9825650354, Mr. Akshat Khare <akshat@nessa.in> M: 9016111723
77	LIGHTING FIXTURES (LED)	M/s. Forus Electric Pvt. Ltd.	M/s. Forus Electric Pvt. Ltd. B-313, Okhla Industrial Area, Phase-1, New delhi-110020	Mr. Amit Bharadwaj <amit.bharadwaj@foruselectric.com > M 8800508090, Mr. Uttam Goyal <uttam@foruselectric.com> M: 8527652687
78	LIGHTING FIXTURES (LED)	M/s. ORIENT ELECTRIC LIMITED.	C- 130, Sector-63, Noida-201301, Uttar Pradesh, D-209, Sector-63, Noida-201301, Uttar Pradesh	Birjendra Kumar Yadav <birjendra.yadav@orientelectric.com > P. +91-120-4894900 , +91-9599848491
79	LIGHTING FIXTURES (LED)	M/s Mika Engineers	Survey no. 47, shed no. 2, AGHAI, Shahpur-wada road, AGHAI Thane, Maharashtra-421601	''deepak'' <deepak@mikaengineers.com>MOB: 8976737543
80	LIGHTING FIXTURES (LED)	M/s Kalingia Illuminaton Pvt Ltd.	15/3/2 SITE-IV SAHIBABAD INDUSTRIAL AREA GHAZIABAD UP 201010	Bidyut Mandal' <bidyut.mandal@kalingialights.com> (M: 9555367941 / 9315029882), 'Suresh Shiromani' <suresh.shiromani@kalingialights.com>, 'info@kalingialights.com', 'kalingialights@gmail.com'

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES53	LV MOTORS (NON FLAME PROOF)	1	A24	ABB	14, MATHURA ROAD, FARIDABAD, HARYANA-121003	0129-2567580, 09871799449	
	LV MOTORS (NON FLAME PROOF)	2	E1027	BHARAT BIJLEE LTD.	BHARAT BIJLEE LIMITED, 1ST FLOOR, 7-B, RAJINDRA PARK, PUSA ROAD, NEW DELHI - 110 060.	Tel.: + 91 (11) 25816931-33, 35 & 36| DT: +91 25724318 Fax: + 91 (11) 25819640| M:+ 91	
	LV MOTORS (NON FLAME PROOF)	3	C02	CROMPTON GREAVES	3RD FLOOR, EXPRESS BUILDING,9-10, BAHADUR SHAH ZAFAR MARG, NEAR ITO CROSSING,NEW DELHI-110002, INDIA	91 11 23460700 - 999 Sunil.Das@cgglobal.com	
	LV MOTORS (NON FLAME PROOF)	4	A35	GE-POWER	KAMAK TOWER, 3RD FLOOR, PLOT NO. 12-A, TVK INDUSTRIAL ESTATE, EKKADUTHANGAL, GUINDY, CHENNAI-600032	044-49681447	
	LV MOTORS (NON FLAME PROOF)	5	K01	KIRLOSKAR ELECTRIC CO LTD.	P.O. BOX 5555 , MALLESWARAM WEST ,BANGALORE 560055	Tel: +91-80-23374865 Fax: +91-80-23377706	
	LV MOTORS (NON FLAME PROOF)	6	L04	LAXMI HYDRAULICS PVT. LTD	129/130, INDUSTRIAL ESTATE PATIL NAGAR, HOTGI ROAD SOLAPUR-413003, MAHARASHTRA	0217- 2357001-005	APPROVED UPTO 200KW
	LV MOTORS (NON FLAME PROOF)	7	M01	MARATHON	MARATHON ELECTRIC INDIA PRIVATE LTD.SECTOR - 11, MODEL TOWN, FARIDABAD - 121006	Ph: +91-129-2286421, 2265340, 4006601 to 4006610	
	LV MOTORS (NON FLAME PROOF)	8	A35	NGEF	POCKET NO.10, FLAT NO. 37 & 38, EXPANDABLE DDA FLATS, NASIRPUR DWARKA, PHASE-I NEW	Ph: (011) 2539 7763	
	LV MOTORS (NON FLAME PROOF)	9	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789; 91)-(22)-26730154	
	LV MOTORS (NON FLAME PROOF)	10	S01	SIEMENS	RC-IN I S NR DEL AREA, JIL BUILDING, TOWER-B, PLOT NO. 78, SECTOR 18, GURGAON-122015, INDIA	0124-2842000, 9873424331 amit.bhadauria@siemens.com	
	LV MOTORS (NON FLAME PROOF)	11	HM06	HAVELLS INDIA LIMITED	Plot No. SP 181-189, Industrial Area Phase-II, Neemrana, Dist. Alwar, Rajasthan-301705, India	M: 9644355595 Mr. Kapil Jain (L): +91120-4772317 (Kapil Jain <Kapil.Jain@havells.com>)	APPROVED UPTO 200KW
ES54	LV MOTORS (FLAME PROOF)	1	E1115	RAJINDRA ELECT INDUSTRIES	14 SHAH IND.ESTATE VEERA DESAI RD,ANDHERI(W) MUMBAI-400053	91-22-26730823, 26730789; 91)-(22)-26730154	

SUB-VENDOR LIST

Sl No	Package Name	Supplier Name	Supplier Communication Address
1	INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com
2	INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
3	INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com
4	INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
5	INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com
6	INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com
7	INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
8	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com
9	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
10	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
11	LEVEL GAUGE	BLISS ANAND PVT. LTD.	Mr. Hritik Mishra (Regional Manager) 92B & 93 B , IMT MANESAR Gurgaon Phone- 9560477922 Pincode : 122001 Email : sales@blissanand.com
12	LEVEL GAUGE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
13	LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com
14	LEVEL SWITCH	Flowstar Engineering Pvt. Ltd.,	Mr.Naveen Kumar Saini (CEO) Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 8375881174 Pincode : 121005 Email : fsepl@flowstar.co.in
15	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
16	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
17	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net
18	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BUDENBERG GUAGE CO.LTD.	PO BOX-5, ALTRINCHAM CHESHIRE Phone- 0161-9285441 Pincode : WA14 4ER Email : dhbdelhi@vsnl.net
19	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
20	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
21	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
22	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
23	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
24	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
25	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
26	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de
27	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com
28	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
29	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
30	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mktg@indfos.com
31	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune, Phone- 020-24393577, Pincode : Email : pressure@vsnl.com,
32	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
33	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
34	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzerprocess.co.in
35	TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
36	TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com
37	TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,

38	TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
39	TEMP. ELEMENT	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
40	TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in
41	TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
42	TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com
43	TEMP. ELEMENT	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com
44	TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
45	TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
46	TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
47	TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
48	TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
49	TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
50	TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in
51	TEMPERATURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
52	TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
53	TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com

QUALITY PLAN

General points related to Quality Assurance:

1	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc.
2	Equipments for which quality plan is not covered in the specification, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.
3	Purchaser / Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.
4	The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of specification and in full compliance with the requirements spelt out in applicable codes and standards
4.1	Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, PVC fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.
4.2	Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.
4.3	Visual, dimensional checking of all components of each cooling tower.
4.4	Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.
4.5	Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.
5	For all spares items, the quality requirements as agreed for the main equipment supply shall be applicable.
6	Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.

2) Bidder shall furnish details of proposed test procedures including test lay out, type and level of accuracy of instruments, sample calculation etc.

3) Tests shall be done in accordance with latest edition of Hydraulic Institute Standard, USA.

4) Tested Pump parameters shall be within following tolerances.

At design head	+ 10% of design capacity
At design capacity	5% of design head (Under 152.4 meter) + 3% of design head (for 152.4 meter and above)

Results must show no minus tolerance with regard to flow and head.
No minus tolerance on efficiency or positive tolerance on power input at motor terminals shall be allowed.

5) It is preferred to carry out performance, NPSH(R) & Dry Running tests of the boiler feed pump at design speed. However, in case of any constraint of manufacturer to carry out the above tests at design speed, the testing of pump at reduced speed as per HIS guidelines may be proposed to Owner for review and approval.

15.0. LOW PRESSURE PIPING

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
1)	Pipes & Fittings and Metered Bends	Y[a]	Y[b]		Y		Y									
2)	Diaphragm Valves	Y[a]					Y[5]			Y				Y[6]		
3)	Butterfly Valves (Low Pressure)															
a)	Casted Butterfly Valves															
(i)	Body (Cast)	Y[a]	Y[b]				Y		Y	Y	Y		Y[7]			
(ii)	Disc (Cast)	Y[a]	Y[b]													
(iii)	Shaft	Y[a]	Y	Y[c]												
b)	Fabricated Butterfly Valves															Ref. Note 14
4)	Gate / Globe / Swing Check Valves	Y[a]	Y[b]	Y[c]			Y[5]	Y	Y				Y[8]			

Sl.No.	Tests/Check Items / Components	Material Test	DPT/MPI	Ultrasonic Test	WPS/ WQS/PQR	Balancing	Hydraulic / Water Fill Test	Pneumatic Test	Assembly Fit up	Dimensions	Functional/operation al Test	Performance Test	Other tests	All Tests as per Relevant Std	Adhesion / Spark	Remarks
5)	Dual Plate Check Valves	Y^a	Y^b	Y^c			Y	Y	Y				Y^4			
6)	Rolled & Welded Pipes	Y^a	Y^3		Y		Y^1			Y						
7)	Coating & Wrapping of Pipes	Y^2											Y^2			
8)	Tanks & Vessels	Y^a	Y^b		Y		Y									
9)	Strainers	Y^a	Y^b				Y						Y^{11}			
10)	Rubber Expansion Joints	Y^a					Y^{12}		Y				Y^{13}			
11)	Rubber Lining of Pipes	Y^a	Y^b		Y		Y			Y				Y^9	Y	
12)	Hangers & Supports	Y^a						Y								
13)	Fastners	Y^a		Y^b				Y								
14)	Site Welding		Y^1		Y		Y									

Notes:
Y-Applicable

The S.nos. indicated below shall be subscript of Y as indicated in table above.

1. Weld Joints not subjected to hydralic test shall be subjected to 100% RT.

2. Spark Test, Adhesion Test and Material Test for primer and enameled & Coal Tar Tapes as per AWWA-C-203-91

3. DPT on route run and after back gouging and on finish welds.

4. Dry Cycle Test (Spring Cycle Test) for one lakh Cycles shall be carried out as a type test.

5. Seat Leakage Test for Actuator Operated Valves, shall be done with by closing the valves with actuator.

6. Tests on rubber parts per batch of rubber mix such as hardness, adhesion, spark test, bleed test and flex test on diaphragm, type test for diaphragm for 50,000 cycles.

7. Hydraulic Test of Body, Seat and disc-strength shall be carried out in accordance with latest edition of AWWA-C-504 in presence of Owner representatives. Actuator operated valves shall be checked for Seat Leakage by closing the valves with actuator. Seat Leakage Test shall be carried out in both directions.

8. Blue matching, wear travel for gates, valves, pneumatic seat leakage, reduced pressure test for check valves shall be done as per relevant standard. Maximum allowable vacuum loss is 0.5 mm of Hg abs. for valves to be tested for vacuum operation for internal pressure 25 mm of Hg abs. for a period of 15 minutes 9.

9. Hardness, Bleeding Test and Ozone resistance test shall be done on rubber material

10. 2% of welds shall be subjected to DPT.

11. Pressure drop across the strainer for each type and size as a special test shall be carried out

12. During hydraulic and vacuum tests at 25mm Hg abs in 3 positions, the change in the circumference of arch should not be more than 1.5%. 24 hrs after the test permanent set in dimension should not exceed 0.5%.

13. Tests on rubber for tensile, elongation, hardness, hydraulic stability check as per ASTM D 471, ozone resistance test as per ASTM D 1149 aging test and adhesion strength of rubber to fabric, rubber to metal adhesion shall be carried out.

14. For fabricated butterfly valves: UT as per ASTM A-435 on plates material for body and disc. 100% RT as per ASTM, Section-VIII, Division-I, on butt joins of body and disc and post weld heat treatment as per ASME, Section-VIII, Division- I on butt joints of body and disc of thickness above 30mm shall be carried out in addition to other tests indicated for cast butter fly valves.

a) One per heat/heat treatment batch/lot.

b) On machined surfaces only for castings and on finished butt welds.
For shaft/spindles > or = 50

16.0 CONDENSER ON LOAD TUBE CLEANING SYSTEM/DEBRIS FILTER FOR MAIN TURBINE CONDENSER AND DRIVE TURBINE CONDENSER (IF OFFERED)

16.1 General Requirements

Refer QA & I portion of General Technical conditions of technical specification.

16.1.1 Ball Recirculation Pump

(a) All rotating parts shall be dynamically balanced.
(b) Pump casing shall be subjected to hydraulic test at 1.5 times the shut off head or twice the maximum working pressure whichever is higher.
(c) Complete pump assembly shall be subjected to shop performance test at supplier's works.

16.1.2 Ball Sorter / Fabricated Body (housing)

(a) In the case of fabricated design, all butt welds shall be subjected to 10% radiographic/ultrasonic examination. All welds shall be examined by 10% magnetic particle testing method to ensure freedom from surface and sub-surface defects.

Section - M5

CW SYSTEM

TESTS/CHECK ITEMS / COMPONENTS		Material Test	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/ operational st	Performance Test	Other Test	All Test as per relevant Std/ Approved Data Sheets	Remarks
A.	**~~CW PUMPS, CENTRIFUGAL PUMPS~~, SUMP PUMPS, SUBMERSIBLE PUMPS, DRAINAGE PUMPS**								Y[1]	Y		Y[2]			
1	Shaft	Y[a]	Y[b]	Y[c]		Y				Y					
2	Impeller	Y[a]	Y[b]		Y[3]	Y									
3	Suction Bell/Bowl Castings/ Inserts	Y[a]	Y[b]				Y			Y			Y6		
4	Discharge Head / Column Pipes / Distance /Piece/Base Plate	Y[a]	Y[b]		Y[4]		Y		Y						
5	Companion Flanges	Y[a]	Y[b]		Y[5]				Y						
5	Thrust Bearing (Tilting Pad type)	Y[a]	Y	Y					Y	Y				Y	
B.	**BUTTERFY VALVES**						Y[7]		Y	Y	Y		Y8	**Y**	
1	Body & Disc	Y[a]	Y[b]										Y9		
2	Shaft	Y[a]	Y[b]	Y[c]											
3	EH Actuators	Y[a]	Y				Y	Y	Y		Y				
C.	**~~RE JOINTS~~**	Y[a]					Y[10]		Y	Y			Y[14]	Y[14]	
D.	**STOP LOG GATES**	Y[a]	Y[b]						Y	Y			Y[12]		
E.	**PIPES**	Y[a]	REFER NOTE 16												
F.	**CRANES & HOISTS**	REFER SEPARATE TABLE FOR QA CHECKS ON EOT CRANES AND HOISTS													

G.	**VENTILATION FANS**									Y		Y		Y	
1)	Hub/Blades/Casing /Impeller	Y	Y			Y									
2)	Shaft	Y[a]	Y	Y[c]											
3)	Pre/Fine Filters												Y[14]		
H.	**GATE, GLOBE, CHECK, VALVES, PIPINGS & SPECIALITIES**	Y[a]	Y[b]	Y[c]			Y[15]		Y	Y	Y	Y	Y[15]	Y	

Notes:	
Y	Applicable
Y[1]	One per Heat/ Heat Treatment Batch/ Lot.
Y[2]	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components.
Y[3]	For Shaft diameter 40 mm and for plate thickness 40 mm (in case of EOT crane components)
Y[4]	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
Y[5]	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics
Y[6]	In case of CW pump impellers, Radiographic Examination shall be conducted as per ASTM E186/446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
Y[7]	Spot Radiography for Butt weld of Fabricated Components for thickness below 37.5 mm shall be carried out. If thickness is 37.5 mm, 100% RT shall be carried out. (RT may be replaced by Ultrasonic Test due to constraint if any.) Stress relieving shall be carried out as per norms of ASME Section VIII.
Y[8]	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any). Maximum number of segments shall be 4 only.
Y[9]	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
Y[10]	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
Y[11]	For Proof of Design Test refer respective chapters of engineering portion in the technical specification.
Y[12]	For Butterfly Valves of Fabricated construction (Sizes 600mm and above), butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Components shall undergo stress relieving.
Y[13]	During Hydraulic & Vacuum test at 25mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.
Y[14]	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D- 471, Ozone Resistance test as per ASTM D-1149, Aging test, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.
Y[15]	Smooth operation and Leakage test shall be carried out at site.

Y[16]	Followings are the testing requirements for fabrication of pipes at site	
	Tests	**Quantum of Check**
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% for pipes up to 1200 mm diameter
	DPT after back gauging	100% for pipes above 1200 mm diameter
	Rt	5%
	DPT on finished butt weld joints	10%
	Hydraulic Test	100%, 1.5 times the design pressure or 2 times the working pressure whichever is higher
Y[17]	Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out	
Y	a. All pipes and fittings shall be tested as per applicable code. b. All strainers shall be subjected to Hydraulic pressure test for leakage and Pressure drop v/s Flow for each type and size. c. All valves shall be hydraulically tested for body, seat and back- seat (if applicable) as per relevant standard. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure. d. Valves shall be offered for hydro test in unpainted condition e. Functional checks of the valves for smooth opening and closing shall also be done. f. Anti-corrosive protection shall be tested as per applicable code.	

QUALITY ASSURANCE (NDCT)

SN	TESTS/CHECK / ITEMS / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	Ultrasonic test	DPT/MPI	Balancing	Assembly Fit up	Dimension	RT	Hydraulic / Water Fill	Test as per relevant Std/ Approved Data Sheets	Other Tests
1	**PVC FILL & DRIFT ELIMINATOR**	Y[1]					Y	Y			Y	Y[2]
2	**GATE/ GLOBE/ CHECK VALVES**	Y[a]			Y[b]		Y			Y	Y	Y[3]
3	**BUTTERFLY VALVES**				Y		Y	Y		Y	Y	Y[4]
3.1	Body (Cast) , Disc (Cast)	Y[a]			Y[b]			Y				
3.2	Body & Disc both fabricated	Y[a]	Y	Y	Y[b]			Y	Y[5]			
3.3	Shaft	Y[a]		Y[c]	Y[b]			Y				
4	**ROLLED & WELDED PIPES.**	Y[a]	**REFER NOTE – 6 FOR ALL CHECKS**									
5	**WRAPPING & COATING OF PIPES**	Y[7]						Y			Y	Y
6	**HOISTS & CHAIN PULLEY BLOCKS**	Y[a]	Y		Y		Y	Y			Y	Y[8]
7	**VENTILATION FANS**	Y[a]	Y	Y[c]	Y[b]	Y	Y	Y			Y	Y[9]
8	**RE JOINTS**	Y[a]					Y	Y		Y[10]		Y[11]
9	**Fiber Glass- Reinforced Pipes**	The FRP pipes shall conform to CTI-154										

	Legend/ Notes:
a.	One per Heat/Heat Treatment batch/Lot
b.	On machined surfaces only of castings and forgings. Also 100% after root run/ back gauging for butt welds and 10% after final butt welds and fillet welds.

c.	UT shall be done for shafts with Diameter 50 mm or above & Plates of Thickness 25 mm or above.	
1.	PVC material shall meet the requirements of CTI Bulletin STD-136. However impact test may be done as per ASTM-D-256 and Flammability test may be done as per ASTM-D-635 with extinguishing type PVC. Density & VICAT softening temperature tests shall also be conducted.	
2.	UV exposure shall be carried out on samples, at reputed third party laboratories as per ASTM -G26 method- C/standard specified in engineering portion of the specification for cooling tower. Impact test before and after UV exposure shall be conducted as per ASTM D-256.	
3.	Blue matching, Wear travel for Gate valves & reduced pressure test for Check valves shall be conducted as per relevant standards.	
4.	For POD of Butterfly Valves refer respective engineering section of the technical specification.	
5.	In case of fabricated construction of Butterfly Valves and companion flanges, UT on Plates of Thickness 20 mm or above for body and disc, and RT on 100% Butt welds shall also be carried out. Welders and WPS shall be qualified as per ASME section -IX. Stress reliving after complete welding shall be carried out as per ASME Section - IX	
6.	Tests	Quantum of Check
	WPS, PQR, Welder Qualification Test	100%
	DPT on root run	100% on pipes up to 1200 mm diameter
	DPT after back gauging	100% on pipes above 1200 mm diameter
	RT/ UT by TOFD Technique/PAUT	5% (covering 100% of `T'-joints)
	DPT on finished welds	10%
	Hydraulic Test	100%, Test pressure = 1.5 times the design pressure or 2 times the working pressure whichever is higher.
	Note:- After erection, the complete piping system shall be tested at 1.5 times, the design pressure or two times the maximum working pressure whichever greater. No leakage/seepage is acceptable. Butt weld joints which would not be hydro-tested shall be subjected to 100% RT test/ 100% UT by TOFD /PAUT Technique.	
7.	Spark test, adhesion test and material tests for primer & enamel and coal tar tapes as per IS: 10221 & IS 15337.	

8.	Ropes shall meet relevant Code requirements. All motions & safety features shall be tested at Works. Full load & 25% overload test shall also be conducted at works. At site, Full load test shall be conducted with all motions and safety features.
9.	One Fan of each type & size will be performance tested as per corresponding Code, for Air Flow, Static pressure, Total pressure, Speed, Efficiency, Power Consumption, Noise, and Vibration & Temperature rise. Also, all fans shall be subjected to run test of 4 hours during which Noise, Vibration, Temperature rise & current drawn shall be measured.
10.	During Hydraulic & Vacuum test at 30 mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.
11.	Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D-471, Ozone Resistance test as per IS: 3400 Part 20, Aging test, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	M	C	N	
					M	C/ N								
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:	Kunal Gandhi	KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

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Approved by:			

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

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ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-507-E002, REV 03	
	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 1 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					6					*	**			
					M	B/C				D	M	B	C	
1	2	3	4	5			7	8	9					
1.0	**RAW MATERIALS**													
1.1	**Aluminium /Copper Rods**													
	(Conductor/ Armour Wire)	a) Make	MA	Verify	100%	100%	Manufacturer approved source	Manufacturer approved source	Test Cert.	✓	V	V	-	
		b) Grade	MA	-do-	-do-	-do-	IS:8130 (Al), IS:613 (Cu)	IS:8130 (Al), IS:613 (Cu)	-do-	✓	V	V	-	
		c) Resistivity	MA	Electrical Tests	Manufacturer std.	Manufacturer std.	IS:613 (Cu), IS:5082 (Al)	IS:613 (Cu), IS:5082 (Al)	-do-	✓	P	V	-	
1.2	**XLPE Compound for insulation**													
		a) Make	MA	Verify	100%	100%	Manufacturer approved source	Manufacturer approved source	Test Cert.	✓	V	V	-	
		b) Type/ Grade	MA	-do-	-do-	-do-	-do-	-do-	-do-	✓	V	V	-	
		c) Shelf life/ Storage condition	MA	-do-	-do-	-do-	Compound mfg std	Compound mfg std	-do-	✓	V	V	-	

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
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Prepared by:	VIKAS KUMAR SINGH		Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-507-E002, REV 03	
	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 2 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					6					*	**			
					M	B/C				D	M	B	C	
1	2	3	4	5			7	8	9					
1.3	**PVC Compound (for sheath)**													
		a) Make	MA	Verify	100%	100%	Manufacturer approved source	Manufacturer approved source	Test Cert.	✓	V	V	-	
		b) Type/ Grade	MA	-do-	-do-	-do-	Approved datasheet	Approved datasheet	-do-	✓	V	V	-	
		c) Shelf life/ Storage condition	MA	-do-	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	✓	V	V	-	
1.4	**Fillers (as applicable)**	1. Make/ Type/ Grade	MA	Verify	Manufacturer standard	Manufacturer standard	Manufacturer approved source & Approved datasheet	Manufacturer approved source & Approved datasheet	Test Cert.	✓	P	V	-	Fillers material chosen shall be compatible with the temperature rating of the cable and shall have no deleterious

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Prepared by:	VIKAS KUMAR SINGH		Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	B/C				*	**			
										D	M	B	C	
1	2	3	4	5	6		7	8	9					
														effect on any other component of cable)
1.5	**Galvanised steel wire/strip for Armour (as applicable)**	GENERAL:												
		1. Make	MA	Verify	Manufacturer std.	Manufacturer std.	Manufacturer approved source	Manufacturer approved source	Test Cert.	✓	P	V	-	
		2. Dimension	MA	Measurement	1 sample each size	1 sample each size	Appd. Data Sheet	Appd. Data Sheet	-do-		P/V	-	-	
		3. Phy.and Elec. Properties	MA	Physical & Electrical Tests	Sample*	Sample*	IS 3975	IS 3975	-do-	✓	P/V	V	-	
		4.Galvanization Quality (Acceptance test as per IS 3975)	MA	Galv.Tests	-do-	-do-	IS 3975	IS 3975	-do-		P/V	-	-	

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Prepared by:	VIKAS KUMAR SINGH		Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-507-E002, REV 03	
	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 4 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	B/C				* D	** M	B	C	
1	2	3	4	5	6		7	8	9					
1.6	**Wooden Drum (if applicable as per approved data sheet)**	1. Phy. & Constructional checks	MA		Manufacturer Plant Std.	Manufacturer Plant Std.	IS 10418	IS 10418	Test Cert.	✓	P	V	-	
		2. Anti termite treatment	MA	Chem.	Manufacturer Plant Std.	Manufacturer Plant Std.	Manufacturer Plant Std.	Manufacturer Plant Std.	-do-	✓	P	V	-	
1.7	**Steel Drum (if applicable as per approved data sheet)**	1. Dimension	MA	Meas.	-do-	-do-	Approved drg	Approved drg	Test Cert.	✓	P	V	-	
		2. Surface finish	MA	Visual	-do-	-do-	-	Surface shall be smooth	-do-	✓	P	V	-	
2.0	**IN PROCESS**													
2.1	Wire Drawing	1. Size	MA	Dimensional	Plant Mfg. Std.	Plant Mfg. Std.	Approved datasheet	Approved datasheet	Inspection Report/	✓	P	V	-	

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Prepared by:	VIKAS KUMAR SINGH		Checked by:					Reviewed by:			
Reviewed by:			Reviewed by:					Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
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	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 5 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	
									Test report					
		2. Surface finish	MA	Visual	-do-	-do-	Surface shall be smooth	Surface shall be smooth	-do-	✓	P	V	-	
		3. % of Elongation	MA	Mechanical	-do-	-do-	IS 8130	IS 8130	-do-	✓	P	V	-	
2.2	**Stranding of wires**	1. No. of wires	MA	Counting	One Sample of each size	One Sample of each size	Approved data sheet	Approved data sheet	Inspection Report/ Test report	✓	P	V	-	
		2. Resistance	CR	Electrical	-do-	-	-do-	-do-	-do-	-do-	P	-	-	
		3. Sequence, lay length & Direction	MA	Visual, Meas.	One Sample of each size	-	Manufacturer Std. / Approved data sheet	Manufacturer Std. / Approved data sheet	-do-		P	-	-	
		4. Surface Finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	-do-		P	-	-	

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	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	VIKAS KUMAR SINGH	Digitally signed by VIKAS KUMAR SINGH DN: cn=VIKAS KUMAR SINGH, o=BHEL, ou=PS CEM NOIDA, email=VIKASKSINGH@BHELIN, c=IN Date: 2024.02.27 18:27:35 +05'30'	Checked by:					Reviewed by:			299 of 347
Reviewed by:			Reviewed by:					Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-507-E002, REV 03	
	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 6 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	B/C				* D	** M	B	C	
1	2	3	4	5	6		7	8	9					
		5. Dimension	MA	Measurement	One Sample of each size	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
2.3	**Core Insulation (XLPE)** (No repair permitted)													
		1. Surface finish	MA	Visual	100%	100%	Free from bulging, burnt particles, lumps, cuts & scratches	Free from bulging, burnt particles, lumps, cuts & scratches	Inspection Report/ Test report	✓	P	V	-	
		2. Eccentricity & Ovality #	CR	Measurement	One Sample of each size	One Sample of each size	Manufacturer Std / Approved data sheet	Manufacturer Std / Approved data sheet	-do-	✓	P	V	-	
		3. Insulation Thickness	CR	Measurement	-do-	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		4. Dia over insulation	MA	Measurement	-do-	-	-do-	-do-	-do-		P	-	-	

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
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Prepared by:	VIKAS KUMAR SINGH		Checked by:					Reviewed by:			
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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
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	PROJECT:		PO NO.:	
	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 7 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	
		5. Tensile Strength & % Elongation	MA	Mechanical	100%	-	IS:1554-I, IS:5831	IS:1554-I, IS:5831	-do-		P	-	-	
		6. Spark Test or Water immersion test	CR	Electrical	100%	-	Manufacturer Std	Manufacturer Std	-do-	Manufacturer Std	P	-	-	
2.4	**Core Laying**	1. Dia over laid up core	MA	Measurement	One Sample of each size	-	Approved data sheet	Approved data sheet	Inspection Report/ Test report		P	-	-	
		2. Sequence of lay & direction	MA	Visual & Meas.	-do-	-	IS 7098-I & Mfr. Std.	IS 7098-I & Mfr. Std.	-do-		P	-	-	
						-								
2.5	**Inner Sheath Extrusion (as applicable)**	1. Surface finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	Inspection Report/ Test report		P	-	-	
		2. Thickness	CR	Measurement	One Sample	-	Approved data sheet	Approved data sheet	-do-		P	-	-	

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	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
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Reviewed by:			Reviewed by:					Approved by:			

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	
					of each size									
		3. Dia over inner sheath	MA	-do-	-do-	-	-do-	-do-	-do-		P	-	-	
		4. Colour	MA	Visual	-do-	-	-do-	-do-	-do-		P	-	-	
2.6	**Armour (as applicable)**	1. No. of wires/Strips	MA	Counting	At the start of the process	-	Manufacturer Std	Manufacturer Std	Inspection Report/ Test report		P	-	-	
		2. Lay length / Direction	MA	Visual & Meas.	-do-	-	Manufacturer Std.	Manufacturer Std.	-do-		P	-	-	
		3. Dia over armouring	MA	Measurement	-do-	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		4. Coverage	MA	Measurement	-do-	-	-do-	-do-	-do-		P	-	-	
2.7	**Outer Sheath Extrusion (No repair permitted)**	1. Surface finish	MA	Visual	100%	-	Surface shall be smooth	Surface shall be smooth	Inspection Report/		P	-	-	

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	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 9 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	
									Test report					
		2. Sheath Thickness	CR	Measurement	One Sample of each size	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
		3. Dia over outer sheath	MA	-do-	-do-	-	-do-	-do-	-do-		P	-	-	
		4. Embossing/ Sequencial Marking	MA	Visual	100%	-	Approved data sheet	Approved data sheet	-do-		P	-	-	
3.0	**Final Inspection (INTERNAL)**	1. Routine Test	CR	Electrical Tests & Measurement	100%	100%	#	#	-do-	✓	P	V	V	#: Refer Annexure-A to QP
4.0	**Final Inspection (EXTERNAL)**	1. Finish & Length (Cable & cable drum)	MA	Visual	One drum	One drum	Approved data sheet	Free from Porosity, Bulging, Burnt particles, lumps, cuts & scratches	Inspection Report/ Test report	✓	P	W	W	

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	ITEM: LT XLPE POWER CABLE	SYSTEM: CABLE	SECTION: II	SHEET 10 OF 11

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/C				D	M	B	C	
		2. Dimension	MA	-do-	IS 7098-I	IS 7098-I	Approved data sheet	Approved data sheet	-do-	✓	P	W	W	
		3. Armouring - Coverage & No.of Wires/Strips	MA	Visual & Meas.	-do-	-do-	-do-	-do-	-do-	✓	P	W	W	
		4. Marking & Colour Coding	MA	Visual	-do-	-do-	-do-	-do-	-do-	✓	P	W	W	
		5. Acceptance Tests	CR	Phy, Elect. Tests & FRLS Tests	Sample #	Sample #	#	-do-	-do-	✓	P	W	W	#: Refer Annexure-A / Annexure-B to QP.
		6. Type Tests	CR	Physical & Electrical Tests	Sample #	Sample #	-do-	-do-	-do-	✓	P	W / V	W / V	'Witness' required for conduction of Type test; else 'Verification' of type test(s) reports to be done.

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	VIKAS KUMAR SINGH		Checked by:		
Reviewed by:			Reviewed by:		

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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		PROJECT:		PO NO.:	
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Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					6					*	**			
1	2	3	4	5	M	B/C	7	8	9	D	M	B	C	
														#: Refer Annexure-A & Annexure-B to QP.
5.0	**Packing**	End sealing / Polythene wrapping	MA	Visual	100%	100%	Approved data sheet	Approved data sheet	-do-	✓	P	V	-	

NOTES:

A). For lists of routine tests, acceptance tests & type tests refer Annexure-A to SQP.
B). For project specific additional tests (if any); refer Annexure-B to SQP.
C). Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch no. should be traceable to the final cable drum number or batch no.
D). Cable manufacturer to maintain all quality records identified as per all QP stages enumerated above whether it is identified for BHEL verification or witness or not.
E). Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER

P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL

D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	VIKAS KUMAR SINGH		Checked by:		
Reviewed by:			Reviewed by:		

Digitally signed by VIKAS KUMAR SINGH
DN: cn=VIKAS KUMAR SINGH, o=BHEL, ou=S PEM NOIDA, email=VIKASKSINGH@BHEL.IN, c=IN
Date: 2024.02.27 19:09:09 +05'30'

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Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

TYPE/ ACCEPTANCE/ ROUTINE TEST REQUIREMENTS

A. Type Test Conduction:

1. Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test.

2. Sampling:
   a) Type test to be conducted on one size for each type (Al/Cu conductor) of cable.
   b) FRLS & Flammability Test to be conducted only on one sample.

3. Repeat type test(s) are not required, in case the requirements of note no. 2, clause no. 2.2 of IS 7098 1 (as per amendment no. 5 of 2012) are met.

B. Acceptance Test Conduction:

1. Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance tests.

2. Sampling:
   Sampling for acceptance tests shall be as per Appendix-B (Clause 15.2.2) of IS: 7098 Part-I.

3. Flammability Test to be conducted only on one sample.

C. Routine Test Conduction:

1. Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

D. Tests listed in S. No-7.0 & 8.0 shall be conducted only on one sample.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.0	**Tests for Conductor**				
I.	Annealing test	For copper conductor only	T, A	IS 10810 Pt 1	Internal in process Test Report to be furnished for acceptance test

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
II.	Tensile test	For aluminium conductor only (Not applicable for compacted circular or shaped conductor)	T, A	IS 10810 Pt 2	
III.	Wrapping test	For aluminium conductor only (Not applicable for compacted circular or shaped conductor)	T, A	IS 10810 Pt 3	
IV.	Resistance test	For Al/Cu	T, A, R	IS 10810 Pt 5	
2.0	**Tests for Armour Wires/Strips**				
I.	Measurement of dimensions	Applicable for Aluminium wire & GS wire/Strip	T	IS 10810 Pt 36	
II.	Tensile test	Applicable for Aluminium wire & GS wire/Strip	T	IS 10810 Pt 37	
III.	Elongation at break test	Applicable for GS wire/Strip only	T	IS 10810 Pt 37	
IV.	Torsion test	For GS round wire only	T	IS 10810 Pt 38	
V.	Winding / Adhesion Test	For GS strip only	T	IS 10810 Pt 39	
VI.	Uniformity of Zinc coating test	For G. S. wires/Strip only	T	IS 10810 Pt 40	
VII.	Mass of Zinc coating test	For G. S. wires/Strip only	T	IS 10810 Pt 41	
VIII.	Resistivity test	Applicable for Aluminium wire & GS wire	T	IS 10810 Pt 42	
IX.	Wrapping Test	Applicable for Aluminium wire	A	IS 10810 Pt 3	
3.0	**Physical Tests for XLPE Insulation & PVC sheath**				
I.	Test for thickness	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T, A	IS 10810 Pt 6	
II.	Tensile strength and elongation test at break	Applicable for XLPE insulation & PVC outer sheath			
(a)	Before ageing		T, A	IS 10810 Pt 7	
(b)	After ageing		T, A	IS 10810 Pt 7	

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
III.	Ageing in air oven	Applicable for XLPE insulation & PVC outer sheath	T	IS 10810 Pt 11	
IV.	Hot set test	For XLPE insulation only	T, A	IS 10810 Pt 30	
V.	Loss of mass in air oven test	For PVC outer sheath only	T	IS 10810 Pt 10	
VI.	Shrinkage test	For XLPE insulation & PVC outer sheath only	T	IS 10810 Pt 12	
VII.	Hot deformation test	For PVC outer sheath only	T	IS 10810 Pt 15	
VIII.	Heat shock test	For PVC outer sheath only	T	IS 10810 Pt 14	
IX.	Thermal stability test	For PVC outer sheath only	T	IS 10810 Pt 60	
X.	Water absorption (gravimetric) test	For XLPE insulation only	T	IS 10810 Pt 33	
4.0	**Improved Fire performance (FR-LSH) Tests**				
I.	Oxygen index test	*For inner (as applicable)/ outer sheath*	T, A	IS 10810 Pt 58 / ASTMD 2863/ NES 715-I	Applicable for Inner Sheath also, if the same is indicated in Approved Datasheet
II.	Smoke density test	*For inner (as applicable)/ outer sheath*	T	IS 10810 Pt 63 / ASTMD 2843	
III.	Acid gas generation test	*For inner (as applicable)/ outer sheath*	T, A	IS 10810 Pt 59 / IEC-754-1	
IV.	Temperature Index Test	*For inner (as applicable)/ outer sheath*	T	IS 10810 Pt 64 / ASTMD 2863	
5.0	**Flammability Tests**				
I.	Flammability test for bunched cables	For complete cable	T	IS 10810 Pt 62/ IEC-60332 (Part-3-23-Cat-B	Test & Category applicable as indicated in Approved Datasheet
II.	Flammability test for single cable	For complete cable	T, A	IS: 10810 Pt 61 / IEC:60332 Part-1	
III.	Swedish chimney test	For complete cable	A	SEN SS 424 1475 (Class F3)	
IV.	Flammability test	For complete cable	A	IEEE: 60383	
6.0	**Electrical Tests**				
I.	High Voltage Test	For complete cable	T, A, R	IS 10810 Pt 45	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	VIKAS KUMAR SINGH		Checked by:		
Reviewed by:			Reviewed by:		

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
II.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T, A	IS 10810 Pt 43	
7.0	**Anti-rodent and Termite Repulsion test**	For PVC outer sheath only	A	Refer Note	Test applicable if indicated in Approved Datasheet
8.0	**Anti-Fungal Test**	For PVC outer sheath only	A	Self-certification by vendor for anti-fungal property.	
9.0	**Special Tests/ Optional test**				
I.	Hydrolytic Stability Test	For complete cable	**	ASTM D 3137:81	Test applicable if indicated in Approved Datasheet
II.	Ultraviolet Radiation Test	For complete cable	**	BS EN ISO 4892-2	
III.	Cold bend test	For PVC outer sheath only	O (Optional)	IS 10810 Pt 20	
IV.	Cold impact test	For PVC outer sheath only	O (Optional)	IS 10810 Pt 21	
V.	Resistance test for armour	Applicable for Aluminium wire & GS wire	O (Optional)	Table 7, IS 7098 Pt 1	

***** These tests shall be conducted on one sample for the entire contract and duration of these tests shall be 14 days.***

Note: A few chippings of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60-degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a thick filter paper and allow soaking. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound.

PROJECT SPECIFIC REQUIREMENT

PROJECT:

PACKAGE: LT XLPE POWER CABLE

S. No.	TEST	APPLICABLE	TEST CONDUCTION REQUIRED AS	REFERENCE STANDARD	REMARKS
1.					
2.					

PREPARED BY	CHECKED BY	REVIEWED BY	APPROVED BY
NAME: DESIGNATION:	NAME: DESIGNATION:	NAME: DESIGNATION:	NAME: DESIGNATION:

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO	DATE:
BHEL		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.:	DATE:
		ITEM: CABLE TRAYS & ACCESSORIES	SYSTEM: CABLING		SHEET 1 of 3

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
					M	B				D	M	B	C	
1	2	3	4	5	6		7	8	9					
1.0 RAW MATERIAL														
1.1	HOT ROLLED CARBON STEEL SHEET	1 CHEM & PHY PROPERTIES	MA	VERIFICATION OF TC'S	100%	100%	IS -1079	IS -1079	TC	√	P/V	V	-	
		2 DIMENSIONS	MA	MEASUREMENT	100%	-	IS-1730	IS-1730	QC RECORD		P	-	-	
		3 SURFACE FINISH	MA	VISUAL	100%	-	IS-1079	IS-1079	QC RECORD		P	-	-	
1.2	ZINC	CHEM COMP.	MA	CHEM TEST	EACH HEAT	EACH HEAT	IS-209	IS-209	TC	√	P/V	V	-	
2.0 IN-PROCESS														
2.1	FABRICATION	1 DIMENSIONS	MA	MEASUREMENT	100%	100%	APPD DOCUMENT	APPD DOCUMENT	QC RECORD	√	P	V		
		2 WELDING QUALITY	MA	VISUAL	100%	100%	ASME SEC. IX	ASME SEC. IX	QC RECORD	√	P	V		Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.
		3 SURFACE FINISH	MA	VISUAL	100%	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	√	P	V	-	
2.2	SURFACE PREPARATION	1 CLEANING, PICKLING & RINSING & FLUXING	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL						
ENGINEERING			QUALITY			
	Sign & Date	Name		Sign & Date	Name	
Checked by:		MANJU MEENA	Checked by:		Mintoo	
Reviewed by:		HEMA KUMAWAT	Reviewed by:	22/2/24	Haruk	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04	DATE: 04.01.2024
	PROJECT: -NA-		PO NO.:	DATE:
	ITEM: CABLE TRAYS & ACCESSORIES	SYSTEM: CABLING		SHEET 2 of 3

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
					M	B				D	** M	B	C	
1	2	3	4	5	6		7	8	9					
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	MEASUREMENT	CONTINUOUS	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	Galvanization is to be done at galvanization plant listed in Annexure-1 to quality plan.
		2.DROSS	MA	VISUAL	PERIODIC	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, ROUGHNESS, SLAG FLUX, STAIN ETC.	QC RECORD		P/V	-	-	
3.0 FINISHED ITEMS														
3.1	(CABLE TRAY, ACCESSORIES &)	1. DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	IS-2500 (PART 1) LEVEL S-4	APPD.DRG	APPD. DOCUMENT	INSP.REPORT	√	P	W	-	
		2. SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS,FLUX, STAIN ETC.	INSP.REPORT	√	P	W	-	
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	05 No./ LOT/	05 No./ LOT/	APPD. DRG	APPD. DOCUMENT	INSP.REPORT	√	P	W	-	600MM wide Ladder & perforated cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.

BIDDER/SUPPLIER	
Sign &Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:	Manoj	MANOJ MEENA	Checked by:		Manohar Mondoo
Reviewed by:	Hema	HEMA KUSHWAHA	Reviewed by:	20/2/24	Hanuman

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO	DATE:
		CUSTOMER : -NA-		QP NO.: PE-QP-999-507-E005, REV. 04	DATE: 04.01.2024
		PROJECT: -NA-		PO NO.:	DATE:
		ITEM: CABLE TRAYS & ACCESSORIES	SYSTEM: CABLING		SHEET 3 of 3

SL. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
					M	B				D	M	B	C	
1	2	3	4	5	6		7	8	9					
3.0 FINISHED ITEMS														
		4 MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-6745	APPD. DOCUMENT	INSP. REPORT	√	P	W	-	
		5 UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP. REPORT	√	P	W	-	
		6 THICKNESS OF ZINC COATING	MA	PHYSICAL TEST	IS-4759	IS-4759	APPD. DOCUMENT	APPD. DOCUMENT	INSP. REPORT	√	P	W	-	
		7 ADHESION	MA	MECH. TEST	IS-4759	IS-4759	IS-2629	IS-2629	INSP. REPORT	√	P	W	-	
		8. COUPLER PLATE	MA	VISUAL	100%	100%	APPD. DOCUMENT	APPD. DOCUMENT	INSP. REPORT	√	P	W	-	Inspector to mention the total number of bags/bundles of coupler plates, nuts, bolts & washer in the inspection report.
		9. NUT & BOLT	MA	VISUAL	100%	100%	APPD. DOCUMENT	APPD. DOCUMENT	INSP. REPORT	√	P	W	-	
		10. WASHER	MA	VISUAL	100%	100%	APPD. DOCUMENT	APPD. DOCUMENT	INSP. REPORT	√	P	W	-	Further manufacturer shall attach the detail of total number of bags/bundles of the respective items with packing list.
		11. PACKING	MA	VISUAL	100%	100%	APPD. DOCUMENT	APPD. DOCUMENT	INSP. REPORT	√	P	V	-	

NOTES:

1. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **D**: DOCUMENTATION

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V**: VERIFICATION, AS APPROPRIATE **MA**: MAJOR, **MI**: MINOR, **CR**: CRITICAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:			Checked by:		
Reviewed by:			Reviewed by:		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
	CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
	PROJECT: -NA-		PO NO.: -NA-	DATE:
	ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 1 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
					M	B				D	M	B	C	
1	2	3	4	5	6		7	8	9					
1.0 RAW MATERIAL														
1.1	ROLLED CARBON STEEL SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	-	IS1079 (for hot rolled) IS-513 (for cold rolled)	IS1079 (for hot rolled) IS-513 (for cold rolled)	TC		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	IS-1730/	IS-1730	QC RECORD		P	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	IS1079 (for hot rolled) IS-513 (for cold rolled)	IS1079 (for hot rolled) IS-513 (for cold rolled)	QC RECORD		P	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM. TEST	EACH HEAT	-	IS-209	IS-209	QC RECORD	√	P/V	V	-	
2.0 IN-PROCESS														
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	-	APPD.DRG	APPD.DRG	QC RECORD	√	P	V	-	
		2.WELDING QUALITY	MA	VISUAL	100%	-	ASME SEC. IX	ASME SEC. IX	QC RECORD	√	P	V	-	Welding is to be done by qualified welders in accordance with ASME Sec IX article III, WPS, PQR and WPQ to be reviewed during inspection

BIDDER/SUPPLIER	
Sign & Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEGWA	Checked by:		MINTOO
Reviewed by:		MEENA KUSHWAHA	Reviewed by:	22/2/24	Harish

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
	CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
	PROJECT: -NA-		PO NO.: -NA-	DATE:
	ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 2 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					6					*	**			
1	2	3	4	5	M	B	7	8	9	D	M	B	C	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	√	P	V	-	
2.2	SURFACE PREPARATION	1.CLEANING, PICKLING & RINSING & FLUXING	MA	MEASUREMENT	PERIODIC IN EACH SHIFT	-	IS:2629	IS:2629	QC RECORD		P	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS:2629	IS:2629	QC RECORD		P	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	MEASUREMENT	CONTINUOUS	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	Galvanization is to be done at galvanization plant listed in Annexure-I to quality plan.
		2.DROSS	MA	VISUAL	PERIODIC	-	IS-2629	IS-2629	QC RECORD		P/V	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD		P/V	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN ETC.	QC RECORD		P/V	-	-	

BIDDER/SUPPLIER	
Sign &Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEGWA	Checked by:		
Reviewed by:		HEMA KUSHWAHA	Reviewed by:	22/2/24	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
	CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
	PROJECT: -NA-		PO NO.: -NA-	DATE:
	ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 3 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B				D	M	B	C	
3.0 FINISHED ITEMS														
3.1	SINGLE / DOUBLE CHANNELS, CANTILEVER ARMS, CLAMPS	1. DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART-1) LEVEL S-4	IS-2500 (PART-1) LEVEL S-4	APPD.DRG	APPD.DRG	INSP.REPORT	√	P	W	-	
		2. SURFACE FINISH	MA	VISUAL	IS-2500 (PART-1) LEVEL S-4	IS-2500 (PART-1) LEVEL S-4	APPD.DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN ETC.	INSP.REPORT	√	P	W	-	
		3.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-6745/ APPD.DRG	APPD.DRG	INSP.REPORT	√	P	W	-	
		4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP.REPORT	√	P	W	-	
		5.THICKNESS OF ZINC COATING	MA	MEASUREMENT	IS-4759	IS-4759	APPD.DRG	APPD.DRG	INSP.REPORT	√	P	W	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-4759	IS-2629	IS-2629	INSP.REPORT	√	P	W	-	
3.1.1	TYPE TESTING	PHYSICAL	CR	TEST	1 SAMPLE*	1 SAMPLE*	APPD. TYPE TEST PROCEDURE	APPD. TYPE TEST PROCEDURE	INSP.REPORT	√	P	W	-	*1 sample per / offered quantity

BIDDER/SUPPLIER		BHEL						FOR CUSTOMER REVIEW & APPROVAL			
Sign & Date		ENGINEERING			QUALITY			Doc No:			
Seal			Sign & Date	Name		Sign & Date	Name		Sign & Date	Name	Seal
		Checked by:		MANOJ MEGNA	Checked by:			Reviewed by:			
		Reviewed by:		HEMA KUSHWAHA	Reviewed by:			Approved by:			

MANUFACTURER/ BIDDER / SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO : PE-TS-XXX-507-E013	DATE:
	CUSTOMER : -NA-		QP NO.: PE-QP-999-507-013, REV. 03	DATE: 04.01.2024
	PROJECT: -NA-		PO NO.: -NA-	DATE:
	ITEM: CABLE TRAY SUPPORT SYSTEM -BOLTABLE	SYSTEM: CABLING		SHEET 4 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B				D	M	B	C	
3.1.2	WELD INTEGRITY TEST	SOUNDNESS	CR	MAGNETIC PARTICLE INSPECTION (MPI) DIE-PENETRATION (DP)	SAMPLE TESTD DURING TYPE TESTING	SAMPLE TESTED DURING TYPE TESTING	APPD. TYPE TEST PROCEDURE.	NO DEFECT	INSP.REPORT	√	P	W	-	AFTER CARRYING OUT TYPE TEST, WELD INTEGRITY TEST TO CHECK THE WELD SOUNDNESS/ ACCEPTANCE SHALL BE DONE BY MANUFACTURER
4.0	PACKING	SEALING IDENTIFICATION	MA	VISUAL	100%	100%	BHEL APPD. DOCUMENT	BHEL APPD. DOCUMENT	INSP.REPORT	√	P	W	-	

NOTES:

1. LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, **D**: DOCUMENTATION

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,

P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI**: MINOR, **CR:** CRITICAL

BIDDER/SUPPLIER	
Sign &Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEENA	Checked by:		
Reviewed by:		HEMA KUSHWAHA	Reviewed by:	22/2/24	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO:	DATE:
	CUSTOMER:		QP NO.: PE-QP-999-509-E001, R3	DATE:
	PROJECT:		PO NO.:	DATE:
	ITEM: ABOVE GROUND EARTHING MATERIALS	SYSTEM: EARTHING		SHEET 1 OF 2

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
					6						**			
					M	B				D	M	B	C	
1	2	3	4	5			7	8	9					
1.0	**RAW MATERIAL:**													
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION OF TC'S	100%	-	IS 2062	IS 2062	MILL TC	✓	P	V	-	REFER REMARKS AT SL. NO. 3.1
		2. DIMENSIONS	MA	MEASUREMENT	100%	-	IS 1730	IS 1730	QC RECORD	✓	P		-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	IS 1079	IS 1079	QC RECORD	✓	P		-	
1.2	ZINC	1.CHEMICAL COMP.	MA	CHEM. TEST	SAMPLE	-	IS 209	IS 209	QC RECORD	✓	P	V	-	
2.0	**IN PROCESS:**													
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	-	IS 1730	IS 1730	QC RECORD	✓	P	V	-	
2.2	SURFACE PREPARATION	1. CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		2. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	MEASUREMENT	CONTINUOUS	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	GALVANIZATION IS TO BE DONE AT GALVANIZATION PLANT LISTED IN ANNEXURE-1 TO QUALITY PLAN.
		2. DROSS	MA	VISUAL	PERIODIC	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		3.RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	-	IS 2629	IS 2629	QC RECORD	✓	P	-	-	
		4. SURFACE FINISH	MA	VISUAL	100%	-	IS 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN	QC RECORD	✓	P	-	-	
3.0	**FINISHED ITEMS:**													
3.1	MS FLATS	1. CHEMICAL COMP.	MA	CHEM. TEST	1 No./LOT/SIZE	-	IS 2026	IS 2026	LAB TC	✓	P	V	-	NOTE: SAMPLE FOR CHEMICAL TEST SHALL BE SELECTED BY BHEL& TESTING SHALL BE DONE AT NABL/ GOVT. APPD. LAB
		2. DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	IS 1730	IS 1730	INSPECTION REPORT	✓	P	W		

BIDDER/SUPPLIER	
Sign &Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEENA	Checked by:		Suman
Reviewed by:		Sandeep Gadhi	Reviewed by:	22-2-24	Hari

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO:	DATE:
	CUSTOMER:		QP NO.: PE-QP-999-509-E001, R3	DATE:
	PROJECT:		PO NO.:	DATE:
	ITEM: ABOVE GROUND EARTHING MATERIALS	SYSTEM: EARTHING		SHEET 2 OF 2

Sl. No.	COMPONENTS & OPERATIONS	CHARACTERSTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
					M	B				D	M	B	C	
1	2	3	4	5	6		7	8	9					
		3. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	IS 2500 (PART 1) LEVEL S-4	-	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	✓	P	W		
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS 4759	IS 4759	IS-6745	FLATS 5 MM THICK AND OVER 610 GM/SQ.M. FLATS UNDER 5 MM, BUT NOT LESS 2 MM 460 GM/SQ.M.	INSP. REPORT	✓	P	W	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-4759	IS-2633	IS-2633	INSP. REPORT	✓	P	W	-	
		6. THICKNESS OF ZINC COATING	MA	MEASUREMENT	IS-4759	IS-4759	IS-4759	FLATS 5 MM THICK AND OVER=AVG 86 MICRON AND MINIMUM 75 MICRON. FLATS UNDER 5 MM THICK, BUT NOT LESS 2 MM =AVG 65 MICRON	INSP. REPORT	✓	P	W	-	
		7. ADHESION	MA	MECH. TEST	IS-4759	IS-4759	IS 2629	IS 2629	INSP. REPORT	✓	P	W	-	
	NOTE: ITEMS LIKE PIPES/ FLEXIBLE COPPER BRAID/ GI WIRE/ GS ROD/ SHIELDING MAST/ TEST LINK WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE)													
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	BHEL APPROVED DOC	BHEL APPROVED DOC	INSPC. REPORT	✓	P	V	-	

NOTES:

1 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ASME/IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(V) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION, **D**: DOCUMENTATION

** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER, **P**: PERFORM, **W**: WITNESS, **V**: VERIFICATION, AS APPROPRIATE **MA**: MAJOR, **MI**: MINOR, **CR**: CRITICAL

BIDDER/SUPPLIER	
Sign &Date	
Seal	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Checked by:		MANOJ MEENA	Checked by:		Suman
Reviewed by:		Sandeep Lodhi	Reviewed by:	23.2.24	Harish

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.:PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM:STATION LIGHTING SYSTEM	SECTION: II	SHEET 1 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	

1.0 LED TYPE LIGHTING FIXTURES

A	Bought out items / in-process checks													
1.1	LED chip	LED chip efficacy	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	√	P/ V	V	V	At the time of final Inspection
		LED chip CRI & CCT	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	√	P/ V	V	V	At the time of final Inspection
		Reported TM21 (L80) lifetime of LED chip	Major	Visual	Manufacturer Standard	-	LM 80 report	Approved GA drawing	LM 80 report	√	P/ V	V	V	At the time of final Inspection
1.2	LED Driver	Compatibility with LED module / chip, controls & protection features	Major	Visual	Manufacturer Standard	-	Approved GA drawing	Approved GA drawing	Certificate of Compliance	√	P/ V	V	V	Certificate of Compliance by LED driver manufacturer / lighting fixture supplier that driver meets all requirements as per approved GA Drawing
		THD & pf check	Major	Electrical	Manufacturer Standard	-	Approved GA drawing	THD <10% and pf >=0.9	Inspection report	√	P/ V*	-	-	Refer note No. 1

BHEL						BIDDER/ SUPPLIER	
ENGINEERING			QUALITY			Sign & Date	
	Sign & Date	Name		Sign & Date	Name	Seal	
Prepared by:	22/02/24	MEET SAGAR SINGH RAJPAL	Checked by:	23/02/24	Kundan		
Reviewed by:	22/2/24	HEMA KUSHWAHA	Reviewed by:	26.02.24	Harish		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.:PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM:STATION LIGHTING SYSTEM	SECTION: II	SHEET 2 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	B/ C					M	B	C	
1.3	Castings	Freedom from defects	Major	Visual	Manufacturer Standard	-	Manufacturer Standard	Casting shall be free from any defects such as blow holes , surface blisters , cracks and cravities etc.	Inspection report		P/ V *	-	-	Refer note No. 1
1.4	Sheet metal forming and fabrication	Freedom from defects	Major	Visual	Manufacturer Standard	-	Manufacturer Standard	Manufacturer Standard	Inspection report		P/ V *	-	-	Refer note No. 1
1.5	Pre-treatment and powder coating	Pre-treatment process checks, Powder Coating finish, thickness , uniformity of coating and adhesion	Major	Visual, chemical & mech	Manufacturer Standard	-	Manufacturer Standard	Nominal coating thickness 50 microns or more	Inspection report	√	P/ V *	V		Refer note No. 1

BHEL						BIDDER/ SUPPLIER	
ENGINEERING			QUALITY			Sign & Date	
	Sign & Date	Name		Sign & Date	Name	Seal	
Prepared by:	24/2/24	MEET SAGAR SINGH RAJPAL	Checked by:		Kundan		
Reviewed by:	24/2/24	HEMA KUSHWAHA	Reviewed by:	24/2/24	Harish Kumar		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.:PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM:STATION LIGHTING SYSTEM	SECTION: II	SHEET 3 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	
B	**Acceptance Tests on LED Lighting fixtures**													
1	**LED Lighting fixture**	LED chip make	Major	Visual	-		Accepted type test reports (LM80) report	LM80 report	Certificate of compliance	√	V	V	V	
2		Constructional features including: Internal writing , terminal block, earthing terminal, safety chain (if applicable)	Major	Visual	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
3		Degree of protection test in case of lighting fixtures having IP X4 and above rating.	Major	Mechanical	1 Sample per type	1 Sample per type	IS 10322	Approved GA drawing	Certificate of compliance	√	P	W	V	
4		Resistance to dust (applicable if IP5X and above)	Major	Optical	Manufacturer Standard	-	IS 10322	Approved GA drawing	Certificate of compliance	√	P/ V *	V	V	Refer note No. 1
5		Photometry check	Major	Optical	Manufacturer	-	LM79, IS 16106	Approved GA drawing	Certificate of	√	P/ V	V	V	Refer note No. 1

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:	22/02/24	MEET SAGAR SINGH RAJPAL	Checked by:	22/2/24	Kundan			Reviewed by:			
Reviewed by:	24/2/24	HEMA KUSHWAHA	Reviewed by:	22/2/24	Hema			Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.:PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM:STATION LIGHTING SYSTEM	SECTION: II	SHEET 4 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	
					Standard				compliance		*			
6		Dimensions	Major	Visual	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
7		LED driver: THD and pf check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	THD<10% and pf >= 0.9	Inspection report	√	P	W	W	At lighting fixtures supplier test lab.
8		LED driver: Precision current control check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
9		LED driver: Open circuit protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
10		LED driver: short circuit protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
11		LED driver: overload protection simulation check	Major	Electrical	1 Sample per type	1 Sample per type	Approved GA drawing	Approved GA drawing	Inspection report	√	P	W	W	
12		LED driver: surge protection	Major	Electrical	1 Sampl	1 Sampl	Approved GA drawing	Certificate of compliance	Certificate of	√	V	V	V	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	24/02/25	MEET SAGAR SINGH RAJPAL	Checked by:		Kundan
Reviewed by:	24/02/24	HEMA KUSHWAHA	Reviewed by:		Harish

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.:PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM:STATION LIGHTING SYSTEM	SECTION: II	SHEET 5 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY **			REMARKS
					M	B/ C				D	M	B	C	
1	2	3	4	5	6		7	8	9					
		compliance check			e per type	e per type		that surge protection is provided.	compliance					
3.0 JUNCTION BOXES & RECEPTACLES														
A	**Acceptance Tests**													
1	**Acceptance Tests**	Dimensions	Major	MEASUREMENT	100%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	Components shall be of approved Make
2		Paint Shade/ Thickness	Major	VISUAL/MEAS.	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	At the time of final Inspection
3		HV/ IR	Major	ELECT.TESTS	100%	-	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	Inspection report		P	V	-	
4		Degree Of Protection	Major	TEST	1 Sample/Type	-	IS:2147	IS:2147	TEST CERT.	√	P	V	-	
5		Special tests if any, explosion proof etc.	Major	TEST	1 Sample/Type	-	IS:2148	IS:2148	TEST CERT.	√	P	V	-	
6		Operation Check	Major	TEST	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	
7		Mechanical Interlock	Major	TEST	10%	-	Approved GA drawing	Approved GA drawing	Inspection report		P	V	-	
4.0 PACKING														
	PACKING	Soundness of Packing against transit damage	Major	Visual	100%	10%	Approved Packing procedure	Approved Packing procedure	Inspection report	√	P	W	-	

BHEL						BIDDER/ SUPPLIER	
ENGINEERING			QUALITY			Sign & Date	
	Sign & Date	Name		Sign & Date	Name	Seal	
Prepared by:	22/02/24	MEET SAGAR SINGH RAJPAL	Checked by:		Kundan		
Reviewed by:	22/2/24	HEMA KUSHWAHA	Reviewed by:		Harish		

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		S.O./C. NO	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-558-E001, R05	DATE: 22.02.2024
	PROJECT:		PO NO.:	DATE:
	ITEM: LIGHTING FIXTURES, LAMPS & MISC. ITEMS	SYSTEM: STATION LIGHTING SYSTEM	SECTION: II	SHEET 6 OF 6

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									*	**			
1	2	3	4	5	6		7	8	9	D	M	B	C
					M	B/ C							

NOTES:

1. P/V"- means test will be performed either by lighting fixture supplier or their sub-vendor and verified by lighting fixture supplier.
2. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) Indicated in QP shall be referred.
3. Items like ceiling fans, emergency lighting unit, flexible conduit, 24V supply module, ladders, hume pipe, switchboxes, exit signs etc. Will be cleared based on COC (certificate of compliance).

LEGENDS:

*Records, identified with "Tick"(√) shall be essentially included by supplier in QA Documentation,
** **M**: Supplier/ Manufacturer/ Sub-Supplier, **B**: Main supplier/ BHEL/ Third Party Inspection Agency, **C**: Customer,
P: Perform, **W**: Witness, **V**: Verification, as appropriate
MA: Major, **MI**: Minor, **CR**: Critical, **D**: Documentation

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by	22/04/24	MEET SAGAR SINGH RAJPAL	Checked by		
Reviewed by	24/2/24	HEMA KUSHWAHA	Reviewed by		

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No			
	Sign & Date	Name	Seal
Reviewed by			
Approved by			

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
	PROJECT:		PO NO.:	DATE:
	ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 1 OF 4

SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B/ C				D	M	B	C	
1.0	**Raw Material**	(a)Material (b)Thickness (c) Surface Finish (d) Chemical Composition	MA	V/M	100%	100%	Manuf. Std./ Approved Document	Manuf. Std./ Approved Document	Test Certificate	√	P	V	-	
		Verification of make, type, Size & rating of component like indicating lamps, PB's, contactors, relays, switches etc.	MA	Visual	100%	100%	Approved drg. & Datasheet	Approved drg. & Datasheet	Test Certificate	√	P	V	-	Component to be of approved make.
	LIGHTING DISTRIBUTION BOARDS & LIGHTING PANELS													
2.0	**Final Inspection**	1.Dimensions	MA	Measurement	100%	10%	Approved drg./ Datasheet	Approved drg./ Datasheet	Insp. Report	√	P	W	-	
		2. Paint shade/ Paint Finish & thickness	MA	Visual/ measurement	100%	10%	Approved drg./ Datasheet	Approved drg./ Datasheet	Insp. Report	√	P	W	-	
		3. Verification of GA	CR	Visual	100%	100%	Approved drg.	Approved drg.	Insp. report	√	P	W	-	
		4. Verification of BOM	CR	Visual	100%	100%	Approved drg.	Approved drg.	Insp. report	√	P	W	-	
		5. Functional tests (incl. wiring cont.)	MA	Elect	100%	100%	Approved drg	Approved drg.	Insp. report	√	P	W	-	
		6.HV/ IR/ HV	MA	Elect	100%	100%	App.DataSheet	App.DataSheet	Insp. report	√	P	W	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		DEVENDRA SINGH	Checked by:		MUNTOO
Reviewed by:	22/2/24	HEMA KUSHWAHA	Reviewed by:		HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN	SPEC. NO :	DATE:
	CUSTOMER :	QP NO.: PE-QP-999-558-E002, R-3	DATE:
	PROJECT:	PO NO.:	DATE:
	ITEM: DISTRIBUTION BOARD / SYSTEM:	SECTION:	SHEET 2 OF 4

.NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
										*	**			
					M	B/ C				D	M	B	C	
1	2	3	4	5	6		7	8	9					
		7. Degree of protection (including explosion proof if any)	MA	Scrutiny of type test certificates	1/rating	1/rating	IS 13947	IS 13947	Test certificate	√	P	V	-	
		7. Temperature rise test (for complete assembled LDB/ LP)	MA	Scrutiny of type test certificates	1/rating	1/rating	IS 13947	IS 13947	Test certificate	√	P	V	-	
.0	LIGHTING TRANSFORMER													
		1.Routine test	CR	Visual	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		a.) Type/ Rating	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		b). Winding/ Resistance	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		c). Voltage Ratio/ Vector	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		d) Z Volt/ Z Sckt	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		DEVENDRA SINGH	Checked by:		MINTOO
Reviewed by:		HEMA KUSHWAHA	Reviewed by:		HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
	PROJECT:		PO NO.:	DATE:
	ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 3 OF 4

SL.NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
										*	**			
					M	B/ C				D	M	B	C	
1	2	3	4	5	6		7	8	9					
		e).Load Loss/ Current	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		f.) No Load Loss & No Load Current	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		g.) Source Withstand	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		h) Induced O/ V	CR	Test	100%	100%	IS 11171	IS 11171	Insp. report	√	P	V	-	
		2. Type Test	MA	Verification	------	1/Rating	IS 11171	IS 11171	Test Certificates	√	P	V	-	Type Test Certificate Clearance from BHEL/Customer
4.0	PACKING	As per BHEL Appd. Drg./Packing Procedure	MA	Visual	100%	100%	Appd. Packing Drg./ Packing procedure	Appd. Packing Drg./ Packing procedure	Insp. report	√	P	W	-	

NOTES: -

(A)	THE INSPECTION SHALL BE CARRIED OUT ONCE FOR THE MATERIAL OFFERED FOR INSPECTION IN ONE LOT. FOR SUBSEQUENT LOTS AGAINST THE SAME PROJECT, THE MATERIAL CAN BE ACCEPTED BASED ON CERTIFICATE OF COMPLIANCE FURNISHED BY THE VENDOR.
(B)	~~BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST, IF REQUIRED.~~
(C)	~~AFTER PACKING~~ AND PRIOR TO ISSUE OF MDCC, PHOTOGRAPHS OF COMPLETE MATERIAL (TO BE DISPATCHED) SHALL BE SENT TO BHEL-PURCHASE GROUP FOR ~~REVIEW.~~
(D)	IN CASE THERE ARE ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE, THE SAME SHALL BE CARRIED OUT BY THE BIDDER

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	22.12.22	DEVENDRA SINGH	Checked by:		MINTOO
Reviewed by:	22.12.22	HEMA KUSHWAHA	Reviewed by:		HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-558-E002, R-3	DATE:
	PROJECT:		PO NO.:	DATE:
	ITEM: DISTRIBUTION BOARD	SYSTEM:	SECTION:	SHEET 4 OF 4

	WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
(E)	PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
(F)	~~FOR EXPORT JOB, PACKING SHALL BE AS PER BHEL SEAWORTHY PACKING SPECIFICATION~~

LEGENDS:
*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B**: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V**: VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR, **CR**: CRITICAL

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		DEVENDRA SINGH	Checked by:		MINTOO
Reviewed by:		HEMA KUSHWAHA	Reviewed by:		HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
ES30	GALVANISING	1		Jenco Industrial Corporation	Chincholi Bunder Khkar Road Near Link Road Devruwadi Malad (W) Mumbai 400064		
	GALVANISING	2		National Galvanizing Company	66, Barrackpore Kamarhatt Trunck Road Calcutta-700058		
	GALVANISING	3		Sigma Galvanising Pvt. Ltd.	Plot No.C-169, TTC, MIDC Ind Area Navin Mumbai-400705	8725402,8725765	
	GALVANISING	4		B.P. Projects PVT LTD	167A, Vivekananda Road Kolkata-700006	033 2553 1254	
	GALVANISING	5		Standard Galvanisers	Makardah Road, Kabar Para, Bankra, Howarah -711403	28756318/28741986/28725402/28725765	
	GALVANISING	6		Steel Products	National Highway No. 6, Chamrail, Kona, Howrah-711114		
	GALVANISING	7		Unitech Fabricators & Engineers Pvt. Ltd.	Village- Ajab Nagar, P.O. -Molla Simlla, P.S. - Singur, Dist - Hoogly, Pin-712223	022 -27686606/ 1907	
	GALVANISING	8		Shivam Engineers & Fabricators	A0-282-284, Industrial Area, South Side of G.T. Road, Ghaziabad, U.P.		
	GALVANISING	9		B.G. Shirke Construction Technology Pvt. Ltd	72-76, Mundhawa, Pune - 401 036		
	GALVANISING	10		Galbro Ispat Galvanizers Pvt. Ltd.	GUT 11 AND 12, OPP. Kudus Steel,Rolling Mill, Wada, Thane , Mumbai		
	GALVANISING	11		Eros Infrastructures Pvt. Ltd.	G-97, MIDC, Bhutibori , Nagpur-441108, Maharashtra		
	GALVANISING	12		Industrial Perforation (India) Pvt. Ltd.	Ganganagr, Katakhal, Kolkata-700132		
	GALVANISING	13		Indmark Formtech Pvt. Ltd.	Phase - 3, E - 11 / 1, M. I. D. C., Chakan, Pune - 410 501, Maharashtra, India.		
	GALVANISING	14		Namdhari Industrial Traders Pvt. Ltd.	Village Latton Dana, Chandigarh Road, Ludhiana		
	GALVANISING	15		Neha Galvaniser	Jalan Industrial Estate, Gate No-1, 1st Right Choise Lane, Near N.G-6, Jangalpur, PO Domjur Howrah - 700071, West Bengal, India		
	GALVANISING	16		Patny Systems (P) Ltd.	Unit-IV, Sy No. -228/9, Plot No. 6, IP Kuchavaram, Toopran(M) Dist.- Medak, Telegana - 502336		
	GALVANISING	17		Parmar Metal Company	Survey No.207,Veraval (Shapar) Dist. Rajkot, India.		
	GALVANISING			Rukmani Electrical & Components Pvt Ltd	Urla Industrial Area, Urla Sarora Road, Raipur– 493 221 (Chhattisgarh)		

ITEM CODE	ITEM/SERVICE DESCRIPTION	SL NO.	VENDOR CODE	VENDOR NAME	ADDRESS	PHONE	REMARKS
	GALVANISING	18		Rukmani Fab & Gal Pvt Ltd	Shankharidaha Baniyarah, Jalan Industrial Complex, Gate no.3, Lane no. 4, Domjur, Howrah , W.B .- 711411		
	GALVANISING	19		DMP Projects Pvt.Ltd.	Dulagarh Industrial Park , PS-Sankrail , Howrah -711302		
	GALVANISING	20		Vinfab Engineers India Private Limited	Gut no. 224/1 &2 Bhiwandi Wada State Highway, Village khupri, Dist. Thane, Maharashtra -421303		
	GALVANISING	21		Saral Projects & Processors	B-1, Industrial Area, Site-II, Amawan Road Rae Bareli		
	GALVANISING	22		Brahampuri Steels Limited	172 (F) Industrial Area, Jhotwara, Jaipur-302013		
	GALVANISING	23		Indiana Gratings PVT. LTD	F-5, MIDC Jejuri, Pune-412 303		
	GALVANISING	24	AT08	M/s AVAIDS TECHNOVATORS PVT. LTD.	131, MATSYA INDUSTRIAL AREA, ALWAR RAJASTHAN		
	GALVANISING	25	RP08	M/s Ratan Projects & Engineering Co. Pvt. Ltd.	VILL Muslim Para, PO- Barunda, P.S – Bagnan, Howrah – 711 303		

CI.2. MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY)

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)	IBR Certification (if applicable)(R)	Hydro Test(R)	Material Test certificate ®
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y				
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y				
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y			
4. Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y			
5. Temp. Switch	Y	Y	Y	Y	Y	Y			
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y			
7. Vertical indicators	Y	Y	Y	Y		Y			
8. Digital Indicators	Y	Y	Y	Y		Y			
9. Integrators	Y	Y	Y	Y					
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y			
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y			
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y			
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y			
14. Thermowell	Y		Y				Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable									

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions.
2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.
3) Acceptance tests shall be carried out in presence of owner's representative.

CI.6. PROCESS CONNECTION AND PIPING

TESTS / ITEMS	Visual ®	GA, BOM, Layout of component & construction feature®	Dimension ®	Paint Shade/thickness ®	Flattening,flaring,hydrotest,hardness check as per ASTM standard (A)	Component Ratings ®	Wiring ®	Make, Model, Type, Rating®	IR & HV ®	Review of TC for instrument/devices (R)	Accessability of TBs/Devices ®	Illumination,grounding ®	Tubing ®	Leak/Hydro test(A)	Chemical/physical properties of material (A)	Proof pressure test,Dismantling & reassembly test,Hydrulic impulse and vibration test (R)	Tests as per standards & specification
Local Instrument enclosure	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Local instruments racks	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y			
Junction Box	Y	Y	Y	Y*		Y		Y	Y								
Gauge Board	Y	Y	Y	Y		Y		Y		Y			Y	Y			
Impulse pipes and tubes	Y		Y		Y			Y							Y		
Socket weld fittings ANSI B-16.11	Y		Y					Y							Y		Y
Compression fittings	Y		Y					Y						Y	Y	Y	
Instrument valves & Valve manifolds	Y		Y					Y						Y	Y		
Copper tubings ASTM B75	Y							Y									Y

*-applicable for painted junction boxes.
Note: R-Routine Test A- Acceptance Test Y – Test applicable
Note: This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted along with relevant supporting documents.

CI.9. ELECTRICAL ACTUATORS WITH INTEGRAL STARTER

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER													
Test/Attributes Characteristics / ITEM/ COPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard &	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER(IS_9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note:

1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

PAINTING REQUIREMENT

Sl no	Condition	Surface Preparation	Primer Coat	No. of Coats	DFT (Microns)	Intermediate Coat	No. of Coats	DFT (Microns)	Final Coat	No. of Coats	DFT (Microns)	Total DFT
PAINTING OF PIPES												
1	PAINTING OF PIPES SHALL BE AS PER CL. NO. 27.13 OF CHAPTER-27 OF CUSTOMER SPECIFICATION FOR LOW PRESSURE PIPING, VALVES & SPECIALITIES WHICH IS ENCLOSED IN THIS SPECIFICATION.											
CIVIL STRUCTURES												
2	REFER CIVIL SPECIFICATION (BOOK 2 OF 2)											

DOCUMENTATION REQUIREMENT

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY ALL THE BIDDERS ALONG WITH THE BID

Sl. No.	DOCUMENT TITLE
1	PQR CREDENTIALS
2	COMPLIANCE SHEET (DULY SIGNED AND STAMPED)
3	PERFORMANCE GUARANTEE SCHEDULE (DULY SIGNED AND STAMPED)
4	GENERAL ARRANGEMENT DRAWING FOR COOLING TOWER, INCORPORATING ALL RELEVANT DIMENSIONS, COLD WATER CHANNELS / SLUDGE CHAMBER/ SCREENS/ GATES IN THE COLD WATER CHANNEL, STAIRCASE ETC.
5	PUMPING HEAD CALCULATIONS
6	THERMAL DESIGN CALCULATIONS
7	TOWER PERFORMANCE CURVES
8	TECHNICAL DEVIATION SCHEDULE (IF ANY)
9	UNPRICED COPY OF THE PRICE SCHEDULE (INDICATING “QUOTED” FOR THE LISTED
	Notes -
i	Along with the thermal design calculations as specified above, bidder has to submit the calculations for: • Total height of Natural Draft Cooling Tower • Basin sizing • Height of the hot water distribution header • Drift Eliminator sizing • Inlet Louver Sizing • Sludge pit sizing
ii	The GA drawing/ calculations shall be only for reference purpose, same shall not be reviewed/commented by purchaser at this stage and shall be subject to approval only during contract). However, diameter and height of CT during contract stage shall not be less than the proposal dimensions as offered in the bid.
iii	Apart from above no other drgs./docs./data sheets etc. are required to be submitted at bid stage and even if furnished shall not be taken cognizance of.

DRAWINGS & DOCUMENTS TO BE SUBMITTED BY SUCCESSFUL BIDDER AFTER AWARD OF CONTRACT ALONG WITH SUBMISSION SCHEDULE

Sl. No.	DOCUMENT TITLE	SUBMISSION SCHEDULE
BASIC DRAWINGS / DOCUMENTS		
1	GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER	6 WEEKS FROM LOI
2	GA OF C.W. BASIN OF COOLING TOWER	6 WEEKS FROM LOI
3	THERMAL DESIGN & FRICTION LOSS CALCULATIONS AND CHARACTERISTIC & PERFORMANCE CURVES FOR NDCT	6 WEEKS FROM LOI
4	CIVIL DESIGN BASIS OF NDCT	8 WEEKS FROM LOI
5	METHODOLOGY STATEMENT FOR PILING WORKS (IF APPLICABLE)	12 WEEKS FROM LOI
6	STRUCTURAL DESIGN OF XXX MM DIA. BORED CAST IN-SITU TEST PILES FOR COOLING TOWERS PACKAGE (IF APPLICABLE)	12 WEEKS FROM LOI
7	LOCATION OF BORED CAST IN SITU TEST PILES FOR COOLING TOWERS (IF APPLICABLE)	12 WEEKS FROM LOI
8	NUMERATION AND RC DETAILS OF TEST PILE (IF APPLICABLE)	12 WEEKS FROM LOI
9	ANALYSIS AND DESIGN OF FOUNDATION, PEDESTAL & RAKER COLUMN OF NDCT	15 WEEKS FROM LOI
10	ANALYSIS & DESIGN OF POND WALL, POND FLOOR	15 WEEKS FROM LOI
11	ANALYSIS & DESIGN OF NDCT SHELL	16 WEEKS FROM LOI

12	LAYOUT AND DETAILS OF POND FLOOR AND GRILLAGE COLUMN FOOTINGS	16 WEEKS FROM LOI
13	R.C. DETAILS OF PILECAP/FOUNDATION, POND WALL AND PEDESTAL	16 WEEKS FROM LOI
14	GA OF SHELL FOUNDATION AND PEDESTAL OF NDCT	16 WEEKS FROM LOI
15	SHELL PROFILE AND THICKNESS.	16 WEEKS FROM LOI
16	GA & RC OF RAKER COLUMNS OF NDCT	16 WEEKS FROM LOI
17	WIND TUNNEL TESTING : METHODOLOGY AND REPORT	25 WEEKS FROM LOI

Note:

1	Complete MDL for NDCT covering all aspects of Mechanical, Electrical, C&I and CIVIL etc. shall be finalized after award of contract.
2	All design calculations, drawings, BOI Documents etc shall be furnished by the supplier for approval of the purchaser.
3	All documents submitted by the Contractor for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-VI. Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per Annexure-VI.

DRAWINGS & DOCUMENTS TO BE SUBMITTED AS FINAL/AS-BUILT DOCUMENT

Sl. No.	**DOCUMENT TITLE**
1	APPROVED DOCUMENTS
2	CALIBRATION CERTIFICATES
3	O&M MANUAL
4	ALL TEST CERTIFICATES

ANNEXURE-VI

DISTRIBUTION SCHEDULE

S.No.	Description of Document	DESEIN				HPGCL			
		HO		SITE		HO		SITE	
		HC	CC	HC	CC	HC	CC	HC	CC
1.	Drawings, Data Sheets, Calculation, all equipment / Instrument Schedule, BOM etc. a) For Approval b) Resubmission c) For Information	4*	1	-	-	2	1	-	-
2.	Final Approved Documents	1	1	1	1	1	1	4	1
3.	Drawings / Documents 'As Built'	1	1	1	1	2	1	4	1
4.	Type Test Reports (Initial)	4*	1	-	-	2	1	-	-
5.	Type Test Report (Final)	2**	1	1	1	2	1	4	1
6.	Piping / Equipment Analysis (Transient) etc., Model Study Report (Draft) including Input / Output date etc.	4*	1	-	-	2	1	-	-
7.	Piping / equipment Analysis (Transient) etc. Model Study Report (Final Approval) including Input / Output date	2**	1	-	-	2	1	2	1
8.	Erection Manual (Draft)	4*	1	-	-	1	1	-	-
9.	Erection Manual 'Final'	1	1	1	-	1	1	2	1
10.	O&M Manual 'Draft'	4*	1	1	-	1	1	-	-
11.	O&M Manual 'Final'	1	1	1	-	1	1	2	2
12.	Commissioning Procedure 'Draft'	4*	1	-	-	1	1	-	-
13.	Commissioning Procedure 'Final'	2**	1	1	-	1	1	2	1

PRE QUALIFICATION REQUIREMENT (TECHNICAL)

ENQUIRY NO.:

PROJECT: 1 X 800 MW HPGCL DCRTPP YAMUNA NAGAR

1.0 to 4.4.1 BLANK

4.4.2 Natural Draught Cooling Tower

4.4.2.1 Bidder should have designed, constructed and commissioned at least one (1) number Natural Draught Cooling Tower (NDCT) in RCC Construction with cooling water flow not less than 25,000 m^3/hr which should have been in successful operation for at least one (1) year as on 20/03/2025.

4.4.2.2 In case the reference NDCT has been designed by a party other than the bidder, the bidder shall collaborate with a design agency, which has independently designed a NDCT of capacity not less than 25,000m^3/hr in RCC construction and which should have been in successful operation for at least one (1) year as on 20/03/2025.

For Clause 4.4.2.2, the Bidder shall be required to furnish a Deed of Joint Undertaking (DJU) jointly executed by the Bidder and the Collaborator/ Associate and each executant of DJU shall be jointly and severally liable to the Owner for successful performance of the relevant system, as per the format to be provided at the time of placement of order. The Deed of Joint Undertaking (DJU) should be submitted at the time of placement of order on approved vendor. In such a case, the Collaborator/Associate shall be required to furnish an on-demand bank guarantee of INR 10 Million (Rupees Ten Million) for the Collaborator/ Associate of Natural Draught Cooling Tower.

OR

4.4.2.3 Bidder who does not meet the requirements under clauses 4.4.2.1 & 4.4.2.2, can also participate in collaboration/association with a firm who fully meets the requirements at clauses 4.4.2.1 & 4.4.2.2, provided the Bidder has executed projects involving RCC works of tall structures of minimum height of 100m using slip/jump form shuttering.

In such a case, the Bidder shall be required to furnish a Deed of Joint Undertaking executed by the Bidder and its Collaborator/Associate for the successful performance of Cooling Tower, as per the format to be provided at the time of placement of order. The Deed of Joint Undertaking (DJU) shall be submitted before placement of order. In case of award, Bidder and Collaborator/Associate shall each be required to furnish an on-demand bank guarantee for INR 65 million (Sixty-Five Million only) in addition to the contract performance security to be furnished by the bidder.

General notes of the PQR are as under:

1. Bidder to submit supporting documents in English. If documents submitted by bidder are in language other than English, a self-attested English translated document should also be submitted.

2. Notwithstanding anything stated above, BHEL/Customer reserves the right to assess the capabilities and capacity of the bidder to perform the contract, should the circumstances warrant such assessment in overall interest of BHEL/Customer.

3. Consideration of offer shall be subject to customer's approval of bidder.

4. After satisfactory fulfilment of all the above criteria/ requirement, offer shall be considered for further evaluation as per NIT and all other terms of the tender.

PREPARED BY: **NAME:** **DESIGNATION / DEPT.:**	**REVIEWED BY:** **NAME:** **DESIGNATION / DEPT.:**	**APPROVED BY:** **NAME:** **DESIGNATION / DEPT.:**

Annexure-3K
(Provenness Criteria)

I.(A) DETAILS OF Cooling Tower (as per clause 4.4.2.2 of Chapter 04, "Provenness" , Volume II of Bidding Documents

In support of Sub-Qualifying Requirements of Clause 4.4.2.2 of Chapter 04, "Provenness" , Volume II of Bidding Document, we confirm that our Sub-vendor M/ s..... have designed, constructed and commissioned at least one (1) number Natural Draught Cooling Tower in RCC Construction with with cooling water flow not less than 25000 M^3/hr which should have been in successful operation for at least one (1) year as on 20/03/2025.

We further confirm that the reference cooling towers are of the same

type as is being offered by us. The details of the reference cooling tower executed by our Sub-vendor is furnished below:

Sl. No.	Description/Details	Plant
1.	Description of Work and Name of Client	....
2.	Location/Address of the Plant/works	....
3.	Address of the Client (including Contact Person Name, Telephone No, e-mail etc)	....
4.	No. of Cooling Towers	....
5.	Capacity of each Cooling Tower (Cu.M/hr.)	....
6.	Type of Cooling Towers (RCC NDCT)	....
7.	Type of Construction	....
8.	Whether scope of works included	
	(a) Design of Cooling Towers	YES*/NO*

Annexure-3K
(Provenness Criteria)

Sl. No.	Description/Details	Plant
	(b) Construction of Cooling towers	YES*/NO*
	(c) Commissioning of Cooling towers	YES*/NO*
9.	Type of fill used,	.....
10.	Value of Contract/Work (Rs. in million)	.....
11.	Date of order by the client	.....
12.	Date of Commissioning of the Cooling tower	Tower 1: .....
13.	Is the cooling tower in successful operation as on 20/03/25	YES*/NO*
14.	Number of years of successful operation as on 20/03/25	.....years
15.	Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3A-9	YES*/NO*
16.	Whether the reference cooling tower at sl. No. 1 is designed by bidder himself or not	YES*/NO*
17.	If 'No' then furnish the details of cooling Towers/ design proposed	
18.	Experience of designer	
	a. Description of work & name of client	
	b. Location / Address of Plants /work	

Annexure-3K
(Provenness Criteria)

Sl. No.	Description/Details	Plant
c.	Address of client (including contact person name, telephone no., e-mail etc.	
d.	No. of cooling towers	
e.	Capacity of each cooling tower (m3/hr)	
f.	Type of Cooling Towers (RCC NDCT)	
g.	Type of Construction (RCC or not)	
h.	Type of fill used,	
i.	Value of contract/Work (Rs. in million)	
j.	Date of order by the client	
k.	Date of Commissioning of the cooling tower	
l.	Is the cooling tower in successful operation as 20/03/25	

Note : z Sub-vendor to ensure submission of documentary evidences in the form of copies of Letter of Award/purchase order, Clients performance/completion certificate etc for each tower/contract to establish that Sub-vendor has designed, Constructed including the details such as the capacity/type of cooling towers, Commissioning dates etc with the bid in support of the above declarations.

z * Strike off whichever is not applicable.

Date :
Place :

(Signature).....
(Printed Name).....
(Designation).....
(Common Seal).....

Annexure-3K
(Provenness Criteria)

I.(B) DETAILS OF Cooling Tower Bidder (as per clause 4.2.2 of Chapter 04, "Provenness" , Volume II of Bidding Document

In support of Sub-Qualifying Requirements of Clause 4.4.2.1 of Chapter 04, "Provenness" , Volume II of Bidding Document, we confirm that our Sub-vendor M/ s..... have designed, constructed and commissioned at least one (1) number Natural Draught Cooling Tower in RCC Construction with with cooling water flow not less than 25000 M^3/hr which should have been in successful operation for at least one (1) year as on 20/03/2025.

Sl. No.	Description/Details		Plant
1.	Description of Work and Name of Client	.....	.....
2.	Location/Address of the Plant/works	.....	.....
3.	Address of the Client (including Contact Person Name, Telephone No, e-mail etc)	.....	.....
4.	No. of Cooling Towers	.....	.....
5.	Capacity of each Cooling Tower (Cu.M/hr.)	.....	.....
6.	Type of Cooling Towers (RCC NDCT)	.....	.....
7.	Type of Construction	.....	.....
8.	Whether scope of works included		
	(a) Design of Cooling Towers		YES*/NO*
	(b) Construction of Cooling towers		YES*/NO*
	(c) Commissioning of Cooling towers		YES*/NO*

Annexure-3K
(Provenness Criteria)

Sl. No.	Description/Details	Plant
9.	Type of fill used, (splash type or not)	.....
10.	Value of Contract/Work (Rs. in million)	.....
11.	Date of order by the client	.....
12.	Date of Commissioning of the Cooling tower	Tower 1: .....
13.	Is the cooling tower in successful operation as on 20/03/25	YES*/NO*
14.	Number of years of successful operation as on date of bid opening	.....years
15.	Certificate from client to substantiate Bidder's QR data is enclosed at Annexure ..... to this Attachment-3A-9	YES*/NO*

Note : z Sub-vendor to ensure submission of documentary evidences in the form of copies of Letter of Award/purchase order, Clients performance/completion certificate etc for each tower/contract to establish that Sub-vendor has designed, Constructed including the details such as the capacity/type of cooling towers, Commissioning dates etc with the bid in support of the above declarations.

z * Strike off whichever is not applicable.

Date : (Signature).....

Place : (Printed Name).....

(Designation).....

(Common Seal).....

COMPLIANCE CERTIFICATE

1	It is hereby confirmed that the technical specification (Book 1 and Book 2) has been read and understood. We confirm compliance to the tender specification including any prebid clarification and amendments issued prior to techno-commercial bid opening without any deviation.
2	It is hereby declared that any technical submittals which was not specifically asked by BHEL in NIT shall not to be considered as part of bid and shall not be evaluated by BHEL.

Signature of authorised Representative

Name and Designation :

Name & Address of the Bidder

Date