GUJRAT STATE ELECTRICITY CORPORATION LTD.

WANAKBORI STPP UNIT-8

(1 X 800 MW)

VOLUME -IIB

TECHNICAL SPECIFICATION
FOR
COOLING TOWER

Specification No. : PE-TS-408-165-N001 (REV. 0)

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

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

1.1 Volume -I CONDITIONS OF CONTRACT

This consists of four parts as below:

Volume - I A : This part contains instructions to bidders for making bids to BHEL.
Volume - I B : This part contains general commercial conditions of the tender and include provision that vendor shall be responsible for the quality of item supplied by their sub-vendors.
Volume - I C : This part contains special conditions of contract.
Volume - I D : This part contains commercial conditions for erection and commissioning site work, as applicable.

1.2 Volume - TECHNICAL SPECIFICATIONS

Technical requirements are stipulated in Volume II which comprises of:

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

1.2.1 Volume - II B:

This volume is sub-divided into following sections:

Section - A : This section outlines the scope of enquiry.
Section - B : This section provides “Project Information”
Section - C : This section indicates technical requirements specific to the contract, not covered in Section-D.
Section - D : This section comprises of technical specifications of equipments complete with data sheet A, B & C.
Data sheet-A specifies data and other requirements pertaining to the equipment.
Data sheet - B specifies data to be filled by the bidder (Data Sheet B is contained in Volume - III)
Data sheet - C indicates data documents to be furnished after the award of contract as per agreed schedule by the vendor (as applicable).

1.2.2 Volume - III TECHNICAL SCHEDULES

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

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

CONTENTS

SECTION - A

SCOPE OF ENQUIRY

1.00.00 SCOPE

1.01.00 This enquiry covers the complete cooling towers including design, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, erection, site painting, commissioning, testing of 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 for WANAKBORI TPS UNIT-III 1X800 MW

Cement, Structural and reinforced Steels for CT are excluded from Bidder's scope, they shall be free issue by BHEL. Terms and conditions for free issue items being given along with NIT. However for Bid evaluation of the Cooling Tower, Bidder's total price shall be determined after adding cost of Cement & Steel as per rates specified else where in Bidder's total quoted price for the CT.

2.00.00	**GENERAL TECHNICAL INSTRUCTIONS**
2.01.00	It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer/Owner, who will interpret the meaning of drawing and specifications and shall be entitled to reject any component, work or material, which in his opinion is not in conformity with the duty requirements.
2.02.00	The omission of specific reference to any component/ accessory necessary for the proper performance of the equipment shall not relieve the bidder of the responsibility of providing such facilities to complete the supply/ erection / commissioning etc. of cooling tower and its drives at quoted prices.
2.03.00	BHEL's/ owner's representative shall be given access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him.
2.04.00	The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and shipping release issued by BHEL.
2.05.00	In case of any deviation from this technical specification (Vol. IIB) and General Technical Conditions (Vol. IIC), the same shall be indicated in the schedule of deviations. In the absence of duly filled schedules it will be assumed that the bid strictly conforms to the specification.
2.06.00	Un priced copy of the price bid shall be furnished along with the technical bid.
2.07.00	The bidder shall assume full responsibility for the design of the cooling tower and its equipment, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the bidder was directly involved in the design work.
2.08.00	In selecting materials of construction of equipment, the bidder shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled.
2.09.00	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.
2.10.00	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.
2.11.00	The Bidder shall indicate and include in his scope of supply all the necessary start-up, commissioning and recommended spares in addition to mandatory spares.

SECTION – B

PROJECT INFORMATION

VOLUME : IIA

SECTION-II

PROJECT SYNOPSIS AND GENERAL INFORMATION

VOLUME : IIA

SECTION-II

PROJECT SYNOPSIS AND GENERAL INFORMATION

1.00.00 INTRODUCTION

The proposed 1x800 MW Supercritical Thermal Power Project would be set up by Gujarat State Electricity Corporation Limited (GSECL) at Kheda district of Gujarat.

The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on the Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

2.00.00 APPROACH TO SITE

The proposed site is located in Kheda district about 13 kilometers from the nearest commercial town of Balasinor & 10 kilometers from Sevalia town. The National Highway, NH-08, connecting Dakor – Godhra is about 10 kilometers from the site. The State Highway SH – 59 connecting Balasinor – Sevalia is about 2 Kilometers from the site. Nearest railway station to the existing site is Sevalia, located about 8 kilometers from the site on Anand – Godhara main broad gauge line of Western Railway.

Nearby Air Ports are Ahmedabad at a distance of about 110 kilometers from the site and Vadodara at a distance of about 85 kilometers from the site.

3.00.00 LAND

The proposed extension unit will be developed in the existing Wanakbori Thermal Power Station and will be located north east side of the existing plot in the Kheda District of Gujarat. The land of the proposed plant will be filled in upto a desired level. Existing Ash Pond/ Dyke area will be utilized for the extension unit.

4.00.00 SOURCE OF COAL

Indian coal would be sourced from captive mines Machha Kata in Talcher, State – Orissa which are situated about 1800 Kms from the project site. GSECL will arrange for transportation of the coal required for the extension unit from these captive mines by the existing railway facilities for delivery of coal supply to the Wanakbori power station.

CONTENT

5.00.00 **SOURCE OF WATER**

The water required for the new unit shall be obtained from River Mahi, flowing by the side of the existing Wanakbori Power Station.

One (1) new jackwell will be installed on Mahi river for supply of water for new plant. In addition, existing Canal Water and Jackwell Water will have interconnection with new plant to cater plant water requirement of new plant.

6.00.00 **ASH DISPOSAL AREA**

Existing Ash Pond / Dyke area will be utilized for the extension unit. Fly ash silos will be located outside plant boundary wall (but within GSECL land) in the vicinity of the Ash Dyke area.

7.00.00 **SALIENT DESIGN DATA**

7.01.00 Meteorological data of site is given below:-

Elevation above MSL	:	72 M
Max. daily average temp	:	34 °C
Min. daily average temp	:	11.7 °C
Max. Ambient air temp. (daily)	:	34°C
Max. Ambient air temp. (yearly)	:	30°C
Max. Ambient air temp.	:	42°C
Wet bulb temperature	:	28°C
Relative Humidity	:	RH varies within a range from 50% to 95%.
Average annual rainfall	:	750 mm

[Metrological data of Vadodara is attached for reference].

VOLUME : IIA

SECTION-IX

SALIENT DESIGN DATA

[TABLE-I TO TABLE-VII]

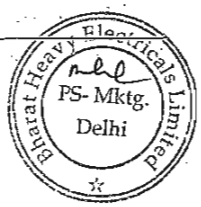

TABLE-VII
CLIMATOLOGICAL TABLE OF BARODA

STATION : Baroda 42747 LAT: 22 18 N LONG: 73 15 E HT. ABOVE M.S.L. 34 METERS DATA 1951 TO 1980

		Mean Temperature		Extremes						Cloud		Rainfall					
MN	SLP	DB	WB	MAX	MIN	HIGH	LOW	MAX DT	MIN DT	RH VP	TOT LOW	TOT	RAINY	WET	DRY	HEAVY	DAY	WS
1	1011.8	13.8	10.9	30.3	12.0	34.3	7.5	36.2 25	-1.1 15	67 10.7	1.1 0.3	1.2	0.1	53.6	0.0	33.0	05	4.0
	1008.5	27.9	17.8					1961	1935	33 12.4	1.1 0.1			1920			1920	
2	1010.3	16.2	12.3	33.0	13.8	37.9	8.9	41.7 28	1.7 10	61 11.2	0.9 0.2	0.6	0.1	33.0	0.0	33.0	10	4.1
	1006.7	31.4	18.7					1953	1950	25 11.3	0.9 0.2			1898			1898	
3	1008.5	22.1	16.3	37.1	18.4	41.5	13.1	44.4 26	6.7 03	53 13.8	1.1 0.2	2.2	0.2	44.3	0.0	21.0	23	4.2
	1004.3	35.8	20.5					1973	1936	20 11.7	1.2 0.2			1967			1967	
4	1005.9	27.3	20.7	40.2	22.9	43.9	18.4	45.9 25 *	11.7 16	53 19.2	1.1 0.2	0.9	0.1	83.3	0.0	71.4	18	4.8
	1001.4	39.1	22.5					1979	1955	20 14.1	1.2 0.2			1947			1947	
5	1003.1	29.9	24.6	40.9	26.5	44.5	23.2	46.7 11	18.9 05	64 26.8	1.7 1.2	4.4	0.3	153.9	0.0	59.7	29	8.7
	998.3	39.8	24.9					1960	1939	27 19.3	0.7 0.3			1917			1917	
6	999.4	29.3	26.0	37.1	27.0	41.5	23.5	45.6 06 *	20.2 19	76 30.9	4.5 2.9	146.8	5.6	527.8	0.0	177.4	06	10.3
	995.4	35.3	26.6					1979	1978	51 27.8	3.4 2.0			1913			1976	
7	998.1	27.4	25.8	32.7	25.7	36.9	23.5	40.6 05	21.1 19	88 31.8	6.5 4.0	297.6	13.8	899.0	4.8	247.4	24	8.4
	995.3	30.8	26.5					1962	1943	72 31.1	6.4 4.0			1950	1899		1927	
8	999.8	26.4	25.1	31.5	25.0	34.6	23.4	37.4 30	22.2 01	90 30.9	6.7 3.8	284.7	12.0	748.5	0.3	250.7	05	7.1
	997.0	29.9	26.1					1979	1976	74 30.6	6.5 3.9			1933	1899		1956	
9	1003.6	26.3	24.5	33.2	24.3	37.0	22.4	41.1 30 *	18.9 29	86 29.4	4.3 2.4	141.7	7.1	575.4	0.0	372.1	24	5.1
	1000.2	31.5	25.7					1951	1938	63 28.2	4.0 2.4			1945			1945	
10	1007.5	25.0	21.5	36.0	21.3	38.5	16.7	41.7 13	11.7 30	72 22.9	1.5 0.6	22.0	1.3	272.3	0.0	153.2	29	3.0
	1004.0	33.3	23.9					1951	1955	44 22.2	1.4 0.6			1917			1930	
11	1010.5	20.4	16.4	34.3	16.7	37.2	12.9	39.6 02	7.2 30	64 15.5	1.3 0.4	16.2	0.7	212.4	0.0	64.6	22	3.0
	1007.2	30.5	21.2					1966	1938	41 17.8	1.3 0.4			1979			1976	
12	1011.9	15.6	12.7	31.4	13.4	34.5	9.6	36.8 01	3.3 22	70 12.5	1.3 0.2	4.4	0.2	43.4	0.0	43.4	01	3.6
	1008.7	28.0	19.1					1980	1937	40 15.1	1.3 0.2			1978			1978	
YR	1005.9	23.3	19.7	34.8	20.6	44.8	6.9	46.7	-1.1	70 21.3	2.7 1.4	922.7	41.5	1666.0	133.1	372.1		5.5
LY	1002.3	32.8	22.8							43 20.1	2.5 1.2			1976	1899			
YRS	30	30	30	30	30	30	30	48	48	30 29	30 22	30	30	93	93	93		30
	30	30	30							30 29	30 22							

* Occurred More Than Once

STATION : Baroda   42747   .. contd

	Weather						Wind speed				% Wind Direction									Total Cloud					Low cloud						Visibility				
MN	PPT	HAIL	THUN	FOG	D.STM	SQUA	62	61	19	0	N	NE	E	SE	S	SW	W	NW	0	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	F8	<1	1-4	4-10	10-20	>20
1	0.3	0.0	0.1	0.5	0.0	0.0	0	0	19	12	13	39	2	2	1	3	1	3	36	20	5	3	2	1	28	2	1	0	0	0	0.3	1.7	2.0	25.6	1.4
							0	0	25	6	12	30	2	0	0	3	8	23	22	19	6	3	2	1	28	2	1	0	0	0	0.0	0.0	0.0	1.9	29.1
2	0.3	0.0	0.1	0.2	0.0	0.0	0	0	17	11	10	31	1	2	2	7	2	4	41	20	4	3	1	0	26	1	1	0	0	0	0.2	1.6	2.3	23.9	0.0
							0	0	24	4	10	21	2	2	0	9	12	28	16	19	5	2	2	0	25	2	1	0	0	0	0.0	0.0	0.0	1.7	26.3
3	0.2	0.0	0.2	0.0	0.0	0.0	0	0	19	12	7	15	1	3	5	16	5	7	41	20	5	4	2	0	29	1	1	0	0	0	0.0	0.5	0.7	29.8	0.0
							0	0	27	4	7	13	2	1	1	15	16	32	13	20	6	3	2	0	28	2	1	0	0	0	0.0	0.0	0.0	1.5	29.5
4	0.2	0.0	0.5	0.0	0.0	0.0	0	0	22	8	5	5	1	2	6	29	10	12	30	19	5	3	2	1	27	2	1	0	0	0	0.0	0.1	0.1	29.7	0.1
							0	0	27	3	4	4	1	0	1	20	26	35	9	16	7	3	3	1	25	4	1	0	0	0	0.0	0.0	0.0	0.3	29.7
5	0.4	0.0	0.6	0.0	0.3	0.0	0	0	28	3	1	1	1	1	5	57	17	7	10	15	6	7	3	0	19	4	6	2	0	0	0.0	0.0	0.0	30.8	0.2
							0	1	29	1	1	2	0	1	2	45	30	14	5	21	8	1	1	0	24	6	1	0	0	0	0.0	0.0	0.0	1.7	29.3
6	7.6	0.0	3.3	0.0	0.1	0.2	0	0	28	2	0	1	0	2	10	61	16	1	9	2	6	9	7	6	6	8	12	4	0	0	0.0	0.0	0.3	29.6	0.1
							0	2	27	1	0	1	0	2	7	61	21	3	5	4	9	6	6	5	8	11	8	3	0	0	0.0	0.0	0.3	1.8	27.9
7	18.8	0.0	2.1	0.0	0.0	0.1	0	0	27	4	0	0	0	1	8	62	14	0	15	0	2	5	8	16	4	4	14	8	1	0	0.0	0.0	0.2	30.8	0.0
							0	1	27	3	0	0	0	2	8	60	18	3	9	1	1	5	11	13	1	7	13	9	1	0	0.0	0.0	0.3	4.3	26.4
8	17.8	0.0	1.8	0.0	0.0	0.0	0	0	26	5	1	0	0	0	7	55	20	1	16	0	1	4	8	18	4	4	13	9	1	0	0.0	0.1	0.8	29.2	0.9
							0	1	27	3	0	1	0	1	6	55	21	4	12	0	2	5	11	13	1	7	14	8	1	0	0.0	1.1	0.4	5.0	24.5
9	10.2	0.0	2.6	0.0	0.0	0.0	0	0	23	7	2	3	0	2	5	37	18	6	27	4	6	6	6	8	12	4	8	5	1	0	0.0	0.1	0.2	29.3	0.4
							0	0	25	5	2	3	1	1	3	32	26	15	17	2	9	6	8	5	6	12	8	4	0	0	0.0	0.0	0.1	2.6	27.3
10	1.6	0.0	1.4	0.2	0.0	0.0	0	0	17	14	6	16	3	6	4	12	3	3	47	17	7	4	2	1	26	2	2	1	0	0	0.0	0.2	0.3	29.7	0.8
							0	0	20	11	9	15	3	2	1	8	10	16	36	14	11	3	2	1	20	9	2	0	0	0	0.0	0.0	0.0	0.5	30.5
11	1.1	0.0	0.3	0.2	0.0	0.0	0	0	17	13	11	33	4	3	1	2	0	1	45	18	6	3	2	1	27	1	2	0	0	0	0.1	0.3	0.4	28.3	0.9
							0	0	18	12	11	24	4	1	0	2	3	13	42	17	7	3	2	1	25	3	2	0	0	0	0.0	0.0	0.0	0.7	29.3
12	0.3	0.0	0.2	0.2	0.0	0.0	0	0	20	11	12	43	3	1	1	1	0	1	38	19	5	4	2	1	29	1	1	0	0	0	0.0	1.3	1.3	27.4	1.0
							0	0	21	10	17	24	4	1	0	2	4	16	32	17	7	3	3	1	28	2	1	0	0	0	0.0	0.0	0.0	0.6	30.4
YR	58.8	0.0	13.2	1.3	0.4	0.3	0	0	263	102	6	16	1	2	5	29	9	4	28	154	58	55	45	53	237	34	62	29	3	0	0.6	5.9	8.6	344.1	5.8
LY							0	5	297	63	6	12	2	1	2	26	16	17	18	150	78	43	53	41	219	67	53	24	2	0	0.0	1.1	1.1	22.6	340.2
YRS				26					24						29							27					27						27		
									24						29							26					26						27		

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STATION : Baroda (A) 42748 LAT: 22 20 N LONG: 73 16 E HT. ABOVE M.S.L. 38 METERS DATA 1952 TO 1980

		Mean Temperature		Extremes						Cloud		Rainfall						
MN	SLP	DB	WB	MAX	MIN	HIGH	LOW	MAX DT	MIN DT	RH VP	TOT LOW	TOT	RAINY	WET	DRY	HEAVY	DAY	WS
1	1011.5	15.2	11.3	29.4	12.2	33.4	7.2	35.8 13	2.8 22	59 10.3	1.2 0.1	1.3	0.1	15.8	0.0	14.0	07	7.6
	1008.1	27.6	17.3					1979	1962	31 11.5	1.2 0.1			1953			1953	
2	1010.0	17.8	12.4	32.1	13.9	36.6	8.8	40.6 28	3.9 10	50 10.2	1.0 0.3	0.7	0.1	11.0	0.0	6.0	02	7.6
	1006.3	30.9	17.8					1953	1950	23 9.9	1.0 0.3			1961			1961	
3	1008.1	23.2	16.5	36.4	18.2	40.5	13.0	43.9 29	9.3 08	48 13.4	1.1 0.2	1.2	0.2	21.4	0.0	11.5	25	7.5
	1003.9	35.1	20.0					1977	1979	21 11.2	1.3 0.2			1967			1967	
4	1005.6	27.8	20.8	39.5	22.8	42.9	18.2	45.9 29	14.4 15	51 19.0	1.2 0.3	0.3	0.0	8.2	0.0	8.2	25	8.3
	1000.9	38.5	21.8					1979	1955	19 12.8	1.5 0.3			1978			1978	
5	1002.7	29.9	24.6	40.3	26.5	43.7	22.9	46.1 20	19.4 27	64 26.6	1.9 1.6	3.7	0.2	50.1	0.0	40.9	29	14.6
	997.7	39.0	24.5					1955	1974	29 19.0	0.9 0.5			1974			1956	
6	999.0	29.3	26.1	36.7	26.8	40.9	23.2	45.6 06	17.1 03	77 31.0	4.9 3.4	129.7	5.0	439.0	0.0	187.3	06	18.0
	994.9	34.6	26.6					1979	1980	54 28.1	3.9 2.5			1976			1976	
7	997.7	27.4	25.8	32.4	25.6	36.2	23.5	39.6 02	22.2 28	88 32.0	6.6 4.1	290.7	12.6	605.6	60.8	162.0	11	15.2
	994.7	30.2	26.5					1968	1952	75 31.6	6.5 3.9			1976	1974		1976	
8	999.5	26.5	25.2	31.3	24.9	34.4	23.2	39.1 16	21.7 16	90 31.0	6.8 3.9	274.4	11.8	657.4	38.5	277.1	05	12.6
	996.5	29.3	26.0					1969	1956	76 30.8	6.5 3.8			1978	1974		1956	
9	1003.2	26.5	24.6	32.7	24.2	36.5	22.2	41.1 29	18.1 25	85 29.4	4.7 2.6	147.0	7.2	456.4	0.3	221.6	07	9.1
	999.7	30.9	25.4					1951	1972	65 28.1	4.5 2.6			1958	1957		1970	
10	1007.2	26.0	21.7	35.4	21.1	37.9	16.5	41.2 15	12.8 27	67 22.6	1.7 0.6	21.6	1.3	143.9	0.0	71.1	01	6.2
	1003.7	32.9	23.0					1980	1960	41 20.2	1.8 0.8			1956			1954	
11	1010.3	21.7	16.7	33.4	16.7	36.2	12.4	39.4 01	6.0 26	58 15.0	1.6 0.4	16.5	0.7	190.1	0.0	61.4	04	6.7
	1006.9	30.2	20.2					1980	1968	37 15.6	1.5 0.5			1979			1962	
12	1011.7	17.3	13.3	30.7	13.7	33.5	9.5	37.2 06	6.4 30	61 12.1	1.5 0.1	3.3	0.2	34.2	0.0	34.2	01	7.0
	1008.3	28.0	18.3					1968	1977	36 13.3	1.6 0.2			1978			1978	
YR	1005.5	24.1	19.9	34.2	20.6	44.1	6.8	46.1	2.8	67 21.1	2.9 1.5	911.1	39.4	1721.7	314.9	277.1		10.0
LY	1001.8	32.3	22.3							42 19.3	2.7 1.3			1976	1972			
YRS	29	29	29	29	29	29	29	31	31	29 28	29 16	30	30	31	31	31		29
	29	29	29							29 28	29 16							

STATION : Baroda (A) 42748 .. contd

MN	Weather: PPT	HAIL	THUN	FOG	D.STM	SQUA	Wind speed: 62	61	19	0	% Wind Direction: N	NE	E	SE	S	SW	W	NW	0	Total Cloud: 0	T-2	3-5	6-7	8	Low cloud: 0	T-2	3-5	6-7	8	F8	Visibility: <1	1-4	4-10	10-20	>20
1	0.2	0.0	0.1	0.2	0.0	0.0	0	1	20	10	34	20	2	4	2	1	1	4	32	19	6	4	2	0	30	1	0	0	0	0	0.3	2.8	14.2	13.1	0.6
							0	2	27	2	26	14	2	0	1	4	11	34	8	19	6	4	2	0	28	2	1	0	0	0	0.0	0.1	2.3	18.9	9.7
2	0.2	0.0	0.1	0.2	0.0	0.0	0	1	18	9	25	18	4	8	5	4	2	5	29	19	4	3	2	0	26	1	1	0	0	0	0.1	2.1	12.1	13.1	0.6
							0	3	24	1	20	13	1	1	1	7	17	36	4	17	6	3	2	0	24	3	1	0	0	0	0.1	0.1	0.9	15.2	11.7
3	0.2	0.0	0.3	0.1	0.1	0.0	0	2	22	7	14	12	4	9	11	12	6	8	24	18	7	4	2	0	28	2	1	0	0	0	0.1	1.3	10.8	18.0	0.8
							0	4	26	1	11	5	2	1	1	11	24	41	4	16	8	5	2	0	26	4	1	0	0	0	0.0	0.1	0.9	17.0	13.0
4	0.1	0.0	0.5	0.0	0.1	0.0	0	2	24	4	12	5	1	2	10	25	14	20	11	19	6	4	1	0	27	2	1	0	0	0	0.0	0.4	9.8	18.9	0.9
							0	3	26	1	7	2	0	0	1	12	32	43	3	17	7	4	2	0	25	4	1	0	0	0	0.1	0.0	1.8	15.5	12.6
5	0.4	0.0	0.9	0.0	0.3	0.2	0	8	22	1	4	1	0	0	8	46	26	10	5	13	7	8	3	0	16	6	7	2	0	0	0.0	0.1	6.1	23.5	1.3
							0	10	20	1	2	1	0	0	4	38	33	19	3	17	9	3	2	0	23	7	1	0	0	0	0.0	0.1	1.7	17.4	11.8
6	7.1	0.0	4.1	0.0	0.2	0.2	0	10	20	0	1	1	0	2	15	51	25	3	2	1	3	10	11	5	4	6	15	5	0	0	0.0	0.7	9.0	19.3	1.0
							0	19	11	0	1	1	1	1	13	59	19	5	0	4	6	7	8	5	7	11	10	2	0	0	0.1	0.7	5.7	14.3	9.2
7	16.7	0.0	3.5	0.0	0.1	0.2	0	6	25	0	0	1	0	2	14	56	22	2	3	0	0	6	13	12	1	6	17	6	1	0	0.0	1.5	14.4	14.5	0.6
							0	16	15	0	0	0	0	2	17	59	17	2	3	0	0	6	14	11	1	7	17	5	1	0	0.1	1.0	8.3	16.1	5.5
8	17.0	0.0	2.7	0.0	0.0	0.0	0	3	27	1	1	0	0	1	9	55	27	4	3	0	1	3	12	15	2	6	16	6	1	0	0.0	1.4	14.2	14.8	0.6
							0	10	20	1	2	1	0	0	11	56	21	5	4	0	1	5	14	11	1	7	16	6	1	0	0.0	0.7	7.2	17.7	5.4
9	9.9	0.0	3.0	0.2	0.0	0.1	0	1	25	4	4	3	1	3	9	32	27	10	11	3	5	7	10	5	9	7	10	4	0	0	0.0	0.9	11.3	15.3	2.5
							0	4	24	2	5	6	1	1	6	28	31	14	8	1	7	9	9	4	3	13	11	3	0	0	0.0	0.3	3.3	13.3	13.1
10	1.7	0.0	1.6	0.3	0.0	0.0	0	1	23	7	11	15	8	14	11	6	5	6	24	13	8	5	4	1	23	4	3	1	0	0	0.1	0.7	8.5	18.3	3.4
							0	1	25	5	17	16	5	2	2	6	14	24	14	10	12	6	3	0	16	11	4	0	0	0	0.0	0.0	1.4	13.9	15.7
11	1.0	0.0	0.3	0.1	0.0	0.0	0	1	21	8	25	26	11	5	2	0	1	2	28	15	7	4	3	1	26	2	2	0	0	0	0.1	1.0	7.8	18.2	2.9
							0	0	25	5	21	19	11	1	1	2	4	26	15	15	7	4	3	1	23	5	2	0	0	0	0.0	0.1	0.9	15.8	13.2
12	0.3	0.0	0.2	0.1	0.0	0.0	0	1	22	8	33	27	5	4	1	0	0	3	27	16	7	5	2	1	29	1	1	0	0	0	0.1	1.2	11.9	15.9	1.9
							0	1	26	4	25	17	6	2	1	2	6	27	14	16	7	5	3	0	28	2	1	0	0	0	0.0	0.0	0.8	17.7	12.5
YR	54.8	0.0	17.3	1.2	0.8	0.7	0	37	269	59	14	11	3	5	8	24	13	6	16	136	61	63	65	40	221	44	74	24	2	0	0.8	14.1	130.1	202.9	17.1
LY							0	73	269	23	11	8	2	1	5	24	19	23	7	132	76	61	64	32	205	76	66	16	2	0	0.4	3.2	35.2	192.8	133.4
YRS				27					24						26							19					19						19		
									25						27							19					19						19		

Seismic Location

The project site lies in zone III as defined in IS: 1893 (Part 1)-2002. All the structures shall be designed complying with the requirements specified in IS: 1893 (Part-1) -2002 and (Part-4) - 2005.

Wind Pressure

Wind force on structures has been considered as per the provisions of IS: 875 (part-3)-1987. The basic wind speed of 39 m/sec at height of 10m above the ground level and wind assumed to blow in any direction and the most unfavorable condition shall be considered for design.

SECTION - C

SPECIFIC TECHNICAL REQUIREMENTS

SECTION C1 - Specific Technical Requirements (Mech.)
SECTION C2 - Specific Technical Requirements (Electrical)
SECTION C3 - Specific Technical Requirements (Civil)
SECTION C4 - Specific Technical Requirements (C&I)

SECTION – C1

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

1.00.00 INTENT OF SPECIFICATION:

1.01.00 This specification is intended to cover the design, manufacture, inspection/ testing at manufacturer's works, delivery at site properly packed for transportation, unloading/ handling and storage at site, erection including civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for **Wanakbori STPP Unit-8 (1 X 800 MW)** including complete Electrical, C&I and Civil Works as specified and as necessary.

Cement, Structural and reinforced steel required for complete civil works of Cooling Tower are excluded from bidder's scope. These shall be free issue items.

The Natural draft type Cooling Tower covered under this specification is as under.

a) **Wanakbori STPP, Unit-8 (1 X 800 MW)** - 1 (One) No Cooling Tower

The performance parameters and other particulars of Cooling Tower is detailed in Data Sheet-A.

2.00.00 SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:

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

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

The scope of supply/ works including civil works as complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements except for items specifically mentioned in exclusion list of works. Scope of works includes preparation of design and drawings, obtaining necessary approvals, materials, execution as per codes, specification, best Engineering practices and to the satisfaction of BHEL/ Owner for all mechanical, architectural, civil structural, building electrification, etc. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder.

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

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

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

2.01.00 Each Cooling Tower shall be complete with following:

2.01.01 Scope (Mechanical):

a) Incoming hot water piping, including vertical run, supported on cooling tower, Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as marked in the tender drawing enclosed at **Annexure 1 & 2** to Data Sheet - A. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a pressure gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope.

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

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

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

Manual chain pulley hoist, complete with chains and hooks, for lifting of the screens & gates.

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

f) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall.

g) Water Distribution system consisting of troughs/ Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply.

h) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 100 M from sludge pit.
Suitable portable type tripod arrangement for handling of sump pumps to be considered in bidder's scope.

i) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.

2.01.02 Scope (C&I):

a) Removable type Pitot tube at each hot water inlet-piping header to measure the flow (during performance guarantee test only). The Pitot tube shall be left with customer after the completion of the test.

b) One no Pressure gauge and one no temperature gauge at Hot water pipe header at T.P.

c) One no of Anemometer for measurement of wind velocity

d) One no of Psychrometer.

e) Local control panel for sump/ sludge pump (submersible type).

f) Level switches for sump/tank level high/normal/low/very low interlocks.

g) Actuator for Motorised BFV at inlet of hot water pipes.

Refer section-C4.

2.01.03 Scope (Electrical):

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

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

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

2.01.04 Scope (Civil):

a) Complete civil works as detailed in Section – C3 including excavation, shoring, dewatering, strutting, backfilling around underground structures and plinth filling, concrete work including reinforcement, shuttering, sand filling, disposal of surplus soil outside plant boundary sidewalls, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers, all faces of concrete structures. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc.
The scope of this work shall consist of , but not limited to, the design and construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including Piling, if required), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with stop log gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution troughs, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs, sludge pit for each basin section, all other staircases/ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts, including fabrication, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure etc.

b) Supply & application of final painting at site.

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

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

b) Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary.

c) Supply of first fill of lubricants for all equipments under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant.

d) Supply of commissioning spares on as required basis.

e) Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.

3.00.00 Equipment & Services to be provided by Purchaser:

a. Supply and erection of incoming hot water piping up to bidder's terminal point.

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

c. Cold-water outlet channels for cooling tower beyond the bidder's terminal point.

d. For Electrical and Civil works refer Sections C2/ D2 & C3 respectively enclosed herein.

4.00.00 The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'D' & data sheet- A. In the event of any conflict between Section -'D' / data sheet-A' & section 'C', the latter shall prevail. Customer specification for cooling tower is enclosed at sec-C and it shall prevail in the event of conflict.

5.00.00 Thermal Design of Cooling Towers:

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

5.01.00 Sensible heat of evaporated water shall be taken into account for calculating the air flow requirement, as per the following equation.

$G*H = L (T_1-T_2)+(E*V*T_2)$

Where

L	=	Water flow rate in Kg/hr.
T_1	=	Water inlet temperature to the tower in Deg.C
T_2	=	Water outlet temperature to the tower in Deg.C
EV	=	Evaporation loss in Kg/hr. at RH (as specified in Data Sheet-A)
G	=	Air flow rate in Kg/hr.
H	=	Change in enthalpy of air in Kcal/kg.

5.02.00 For the specified design conditions of water rate, range, approach, wet bulb and dry bulb temperatures Bidder shall calculate and furnish the duty coefficient “D”. A nomogram indicating the ratio of water rate and duty coefficient, recooled water temperature and other thermal conditions specified shall be furnished with the bid. The nomogram shall cover the entire operating range and shall extend up to a wet bulb temperature of as specified in Data Sheet-A.

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

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

5.04.00 Bidder shall furnish performance characteristic curves for following variations in design parameters.15%, 25%, 60%, 70%, 80%, 90%, 100%.

Bidder shall also clearly identify various “Guaranteed Zones” as per the requirement of code.

5.05.00 Bidder may note the calculations specified above must be enclosed with the offer without which bids run the risk of rejection. 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.

5.06.00 The tower configuration shall be such that it shall offer minimum restriction to air flow.

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

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

5.08.00 The total CW Pumping head (MWC) within bidder’s terminal points shall not exceed the respective maximum limits specified in Data Sheets A.

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

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

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

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

6.00.00 Specific Requirements

In addition to the salient technical requirements stipulated in Section "D", the bidder may note specific requirements detailed herein for design of the cooling towers.

6.01.00 No wood/ timberwork shall be used in any component of the cooling tower.

6.02.00 The quality of water in CW sump shall be clarified water with analysis as given in data sheet-A of Section. D.

a) The COC in CW System shall be '**5'**.

b) Chlorinatiom to control biological/ algae growth is envisaged in purchaser's scope.

6.03.00 The location, orientation, wind rose, scope demarcation, water levels etc. for the cooling tower shall be as per the sketch enclosed at Annexure – 1 & 2.

6.04.00 Fills shall be PVC Film fills in easily removable sections.

6.05.00 PVC Drift eliminator blades shall be of three-pass full wave type supported on concrete framework & shall limit the drift losses to a value not greater than 0.005 % of the design water circulation rate.

6.06.00 All parts subjected to periodical maintenance & inspection such as Inlet louvers (if applicable), fills, drift eliminators etc. shall be readily accessible.

6.07.00 Access doors shall be provided for entry into cooling water distribution level. The doors shall have easily operable shutter of leak proof design & shall be of MS construction with 2 coats of red oxide zinc chromate primer

6.08.00 Two R.C.C. staircase for approach to hot water distribution level & aviation warning lamp lamp etc.

6.09.00 Two external cage ladders for approach to top of cooling tower from ground level.

6.10.00 Access platforms and walkways with handrails for inspection and maintenance of hot water distribution system & aviation warning light etc.

6.11.00 All steel parts in direct contact with water or humid air shall be of SS 316. All other steel parts not in direct contact with water/ humid air shall be galvanized steel. No hardware shall be of Cu or Cu based alloys. Material of construction shall be as indicated in Datasheet "A". Wherever the material of construction for any component is not given, same shall be suitable for the intended service & shall be subject to purchaser's approval during detailed engineering stage in the event of order.

6.12 00 The sizing of the hot water distribution system shall be done by limiting the velocity through the pipes to a maximum of 2 m/sec except of hot water CW header.

6.13.0 a) Piping for sizes above 150 Nb Carbon steel plates to IS 2062, rolled and welded as per IS 3589.
b) Piping up to and including 150 Nb shall be IS 1239 (Heavy Grade).

Required wall thickness for Hot Water riser and Distribution piping shall be as follows:

NB	OD	THK
2500	2540.00	20.0
2700	2740.00	20.0
3700	3740.00	20.0

6.14.00 The buried piping in bidders scope shall be steel pipe. Welding of pipe header with Purchaser's pipe at terminal point shall be in bidder's scope. The thrust block etc. shall also be in bidders scope.

Provision of at least 2 nos. welding sockets at water distribution level shall also be in bidders scope.

6.15.00 Motorised operated B.F. valves shall be provided in hot water distribution riser.

6.16.00 The cold-water basin of cooling tower shall be provided with a partition wall to facilitate isolation of each half of CW basin whenever required through isolating gates viz. minimum two nos. gates shall be provided for each cooling tower. CT basin shall be provided with adequate slope (Min slope of 1:120) towards the sludge sump for drainage purpose.

6.17.00 Under each valve, flange joint & such other items prone to gland/ joint leakage, suitable trays/ channels shall be provided so that any leakage water does not spread on the surroundings. This is also applicable for any air release valve that has to be mounted on hot water riser top. Erection of such air release valves has also to be done by the bidder.

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

7.00.00 Deleted

8.00.00 PERFORMANCE TESTING AT SITE

8.01.00 Scope:

To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test at site in presence of employer / purchaser through **CTI approved testing agency**. Under no circumstances, the bidder himself will conduct the test even if approved by CTI. The testing agency shall be independent from the bidder.

Cooling Tower testing during single visit of CTI approved testing agency is envisaged.

8.02.00 Codes:

The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder.

a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version).
b) BS-4485 : Specification for Water Cooling Tower.
c) BS-1042 : Methods for the measurement of fluid flow in pipes.
d) BS-3435 : Measurement of electrical power and energy in acceptance testing.
e) ASME 19.5 : Supplements on instruments and apparatus.

8.03.00 Conductance of tests:

Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified

8.03.01 The bidder shall submit cooling tower performance test procedure as per ATC 105 in consultation with CTI approved testing agency for approval & conduct the test as per the approved procedure, in the event of order.

8.03.02 The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.

8.03.03 **Test shall be conducted jointly by CTI approved testing agency of the bidder, BHEL and Owner for all the cooling towers. All the representatives shall jointly record data of test**.

i. The responsibility for conducting the test will be with the bidder.

ii. **All test instruments required for the PG test will be provided by CTI approved testing agency / or the instruments provided by contractor if the same meets the stipulations of the CTI testing agency and acceptable to testing agency**

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

iv List of instruments to be arranged by the bidder along with the calibration certificates of the instruments to be used and psychometric charts and tables should be submitted to **CTI**/ owner for approval.

8.03.04 PG test shall be carried out by the bidder after completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.

8.03.05 Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished along with the bid. 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 deg. C, with sufficient scope to cover approximately $\pm$ 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 100% relative humidity. The design conditions shall be indicated on the set applicable to design water flow rate. The dry bulb temperature associated with the wet bulb on each fixed relative humidity graph shall be included. The curves shall fully cover (but not necessarily be limited to) the range of variations specified. All performance curves shall be based on ambient wet bulb temperature.

8.03.06 The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify the equipment as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only once during the contract period . All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).

8.03.07 In case the test cold water temperature as determined from the PG test is higher than the predicated value (based on the performance curves). Owner reserves the right to reject/ accept the tower after assessing the liquidated damages as specified.

8.03.08 It is mandatory to demonstrate drift loss test to ascertain that it is with in permissible limit. Drift loss demonstration procedure shall be subject to customer approval.

9.00.00 The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.

10.00.00 It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the '**Schedule of Deviations**' only. In the absence of the deviations listed in the '**Schedule of Deviations**', the offer shall be deemed to be in full conformity with the specification not withstanding anything else stated elsewhere in the offer, data sheets etc. **The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser**.

11.00.00 PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES

a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified.

In case the test cold-water temperature as determined from the PG test is higher than the predicted value (based on the performance curves). Owner reserves the right to reject the tower. In the event of its acceptance by purchaser liquidated damages as follows shall be applicable.

0.1°C over the guaranteed value	=	400 lacs
0.2°C over the guaranteed value	=	800 lacs
0.3°C over the guaranteed value	=	1200 lacs
0.4°C over the guaranteed value	=	1600 lacs
0.5°C over the guaranteed value	=	2000 lacs
0.6°C over the guaranteed value	=	2400 lacs
0.7°C over the guaranteed value	=	2800 lacs
0.8°C over the guaranteed value	=	3200 lacs
0.9°C over the guaranteed value	=	3600 lacs
1.0°C over the guaranteed value	=	4000 lacs

Bidder to note that the liquidated damages (as specified) for shortfall in performance shall be worked out independently for each cooling tower. To ascertain the fulfillment of guarantees of the cooling towers, the test results of the tower tested through CTI approved testing agency shall be considered for PG test evaluation and based on the test result, the liquidated damage if applicable shall be levied.

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

- Total CW pumping head within the bidder's terminal points viz. static head & frictional losses for cooling tower.

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

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

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

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

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

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

12.00.00 INSPECTION AND TESTING:

Purchaser/ Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.

12.01.00 The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.

12.02.00 Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, PVC fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.

12.03.00 Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.

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

12.05.00 Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.

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

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

13.00.00 QUALITY PLAN:

13.01.00 The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc.

Following standard QP are enclosed for bidder's guidance:

- Cooling tower
- Pipes, fittings & pipe work
- BF Valves
- Chain Pulley Blocks
- Gate/ Globe Valves
- Submersible Pumps

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

13.03.00 For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.

14.00.00 Tests at Site:

14.01.00 after completion of erection and commissioning of the cooling tower, supplier in accordance with cooling tower Institute Bulletin No ATC-105 "Acceptance Test Procedure for Industrial Cooling Tower" shall carry out performance tests of each cooling tower.

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

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

15.00.00 DRAWINGS, CURVES AND INFORMATION REQUIRED:

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

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

<u>Note:</u> 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.

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

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

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

SECTION-2

TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWER

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification is intended to cover supply and installation of One (1) no. of Natural Draft Cooling Tower as detailed hereinafter for 1X800 MW Supercritical Power Project, Unit No. 8 at Wanakbori TPS, Gujarat.

1.02.00 The scope shall include design, engineering, manufacture, assembly/ pre-assembly, tests at manufacturer's works, shop painting, seaworthy packing, complete with all accessories, auxiliaries as specified hereinafter and as required for safe and trouble free continuous commercial operation.

1.03.00 The scope of this specification also includes erection/installation, supervision, including unloading, storage and handling at site, 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 plant

1.04.00 It is not intended to specify completely herein, all details of design and construction of equipments. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation up to the vendor's guarantee in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work of material which in his judgment is not in full accordance therewith.

2.00.00 CODES AND STANDARDS

2.01.00 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:

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

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

2.01.03 PTC-23: ASME Performance Test Code for Atmospheric Water Cooling Equipment.

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

2.01.05 American Society of Testing Materials

2.02.00 The 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.

2.03.00 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.

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.

3.00.00 GENERAL PERFORMANCE REQUIREMENTS

3.01.00 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.

3.02.00 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.

3.03.00 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.

3.04.00 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.

3.05.00 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.

3.05.01 Heat balance calculations.

3.05.02 Justification for the outlet air temperature. This could be in the form of operating experience on existing towers 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.

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

3.05.04 Calculations for tower duty coefficient and performance coefficient.

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

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

3.07.00 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.

4.00.00 SYSTEM DESCRIPTION

4.01.00 The natural draught cooling tower will be located inside the plant boundary and will be used for cooling the hot circulating water returning from the condenser and various other heat exchangers. The circulation of water will be maintained by Circulating Water Pumps and Auxiliary Cooling Water pumps located inside C.W. pump house.

4.02.00 The hot circulating water reaching the cooling tower will be raised to the top of the hot water distribution system of the tower. The hot water distribution pipes inside the Tower shall be fitted with spray nozzles to distribute the hot water evenly over the PVC fill located immediately below. The hot water cools by evaporation as it drains through the PVC fill into the cooling tower basin.

4.03.00 The cooled water will be collected in a circular basin located under the cooling tower. The basin shall have a central partition, such that any half of the basin can be cleaned/ repaired while the other half is in use.

4.04.00 Water from the cold water basins will flow through RCC tunnel to the sump of the C.W. pump house.

4.05.00 The supplier should preferably be in a position to take up maintenance/ overhauling work as and when desired by the Owner during whole life of operation of the plant, on service contract and/or piecemeal basis

5.00.00 DUTY AND CAPACITY

5.01.00 Cooling tower shall be capable of cooling the total quantity of hot condensate circulating water and auxiliary cooling water, through the specified 'Range' at the design wet bulb temperature and other parameters as per Data sheet. This cooling shall be possible even with the maximum or calm wind conditions. The Cooling tower shall be designed for continuous operation throughout the year.

5.02.00 The basin wall curb level shall be minimum 300 mm above the finished grade floor. The grade level surrounding the cooling tower shall provide for effective storm water drainage away from the tower. Depth of basin from well top shall be suitable for 6 minute storage of rated capacity excluding free board of 300 mm and not less than minimum one (1) metre.

5.03.00 The Bidder shall guarantee the tower performance (re-cooled water temperature) for the following range of variation of the parameters:

a) Water quantity : ± 10% of the design flow

b) Cooling range : 85% to 115% of the design cooling range

c) Relative humidity : Above 40%

d) Wet bulb temperature : ± 5 Deg.C

5.04.00 The bidder shall review the analysis of water in circulation. All materials and components furnished under this specification shall be suitable for continuous and reliable operation of the tower with the water in circulation. Special care must be taken to select and use materials and components, which will not corrode, leach or be subject to organic and inorganic deposits or destructive action leading to subsequent failure or erosion by water droplets or be source of electrolytic corrosion being set-up between components. Any materials or components, found inadequate for the service during the first 12 months, after commissioning will have to be replaced at site with suitable material of construction in all towers without any additional cost to the Owner at a time when unit is under shut down.

5.05.00 Re-cooled water from tower basin will be conveyed through a concrete channel to the circulating water sump for recirculation. Hot water will be delivered to the tower through distributing headers. Re-cooled water from tower shall be thoroughly mixed to ensure temperature equalization prior to entering the channel leading to the pumps.

6.00.00 SCOPE OF SUPPLY AND WORKS

The following Equipment shall be supplied under this specification.

6.01.00 General

- 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 cooling tower including all work and services connected herewith.
- Construction of cold water basin, cold water outlet channel/ duct and basin de-sludge arrangement.
- Hot water distribution piping/ducting along with spray nozzle system.
- Supply, shop testing of components and erection of all mechanical equipment, PVC fill, Spray nozzles, etc.

- Complete lightning protection system, aviation obstruction lighting system, earthing including the necessary power distribution arrangement.

6.02.00 **Detailed Scope of Civil Works**

- Excavation and backfilling for columns foundation and substructure below cold water basin level.
- R.C. foundation raft & Cold water Basin, R.C. Shell, R.C. support framework for fill support.
- Hot water distribution duct.
- Painting of concrete surfaces shall be as per approved type of paint.
- Providing and installation of access doors in the shell of cooling tower including the necessary fittings and appliances on Tower Shell. The access doors shall be of heavy duty MS doors duly painted with 3 coats of epoxy paints.
- Main access RC staircase outside the tower up to Hot water Duct top, internal RC walkways and platforms all with necessary galvanized MS pipe handrails.
- Cold water channel outlet into gravity tunnel.
- De-sludging arrangement for each compartment of cold water basin.
- Provision of permanent access ladder up to top of tower manufactured in galvanized mild steel with adequate back-guards and landing platforms. The ladder shall comply with all applicable regulations.
- Provision of peripheral drainage around cooling tower.
- Necessary site clearing and grading all round the tower in accordance with specifications and drawings.
- Water fill test of cold water basin, cold water outlet channel and tunnel.
- Hydro test of Hot water Duct.
- Supply and erection of all anchor bolts, nuts, fasteners, embedded parts and any other likewise material required for completion of the work.
- Any other works not mentioned herein, but sufficiently implied and are necessary for completion and proper functioning of the cooling tower.

6.03.00 **Detailed scope of Mechanical works**

- Hot water distributions spray system of reliable & efficient design, along with its supporting arrangement.
- Hot water duct/pipe work along with supports and anchors.
- Gear operated with chain pulley arrangement isolation valves on hot water inlet piping before hot water distribution system to achieve basin maintenance.
- Painting both inside and outside surfaces of steel pipes with three coats of rust and corrosion resisting paint including thorough cleaning of the surfaces.
- Tower PVC fill, drift eliminators (if felt necessary) including all required supporting structure and accessories, etc. as necessary.
- Screens along with guides embedded in concrete at each of the cold water outlet channels from the cold water basin.
- Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.
- Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates.
- Cold water outlet duct/tunnel.
- 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.
- Tower Fill Hot water By-Pass Nozzle connections on Hot water duct/ piping for system lines flushing during commissioning.
- Instrument tapping provisions on hot water duct/piping and cold water duct/piping for carrying out flow and temperature measurement during PG test.

6.04.00 **Detailed Scope of Electrical Works**

Refer Volume II-F/2, Section-XV, Technical Specification for Chimney and Natural Draft Cooling Tower- Electrical works, Clause no. 2.00.00.

6.05.00 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.

6.06.00 All accessories and hardwares.

6.07.00 One set of special tools and tackles.

6.08.00 All relevant drawings, data and O&M manuals.

6.09.00 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.

7.00.00 **DESIGN AND CONSTRUCTION**

7.01.00 **Hot Water Distribution System**

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

7.01.02 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.

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

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

7.01.05 The sprayers shall be arranged in a uniform pattern with proper distance to produce 10% to 20% 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.

7.01.06 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.

7.01.07 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.

7.01.08 The distribution of water shall be in Troughs/Pipes of approved material. The entire water distribution system shall be self-draining and non-clogging type.

7.01.09 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.

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

a) Self weight.

b) Hydraulic pressure during normal operations, including pressure surges.

c) Hydraulic pressures due to mal-operation of tower or supply pumps.

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

7.01.12 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.

7.01.13 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.

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

7.01.15 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.

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

7.01.17 The nozzles and splash plates shall be made of High Density Polyethylene or approved equal.

7.01.18 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.

7.01.19 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.

7.02.00 **Louver and Casing**

7.02.01 Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.

7.02.02 The louvers and casing may be made of concrete. Concrete casing wall shall be supported from the basin through reinforced concrete. Hinged access door with platforms shall be provided for entry into the tower at suitable locations.

7.03.00 **Fill**

7.03.01 Cooling tower fill shall be made PVC or pre-stressed concrete.

7.03.02 Pre-stressed concrete fill, if used, shall conform to the requirements specified elsewhere in this specification.

7.03.03 The Bidder shall enclose with his proposal a write-up on the method of replacement of damaged/deteriorated fills during the life of cooling tower. Also Bidder's experience with pre-stressed concrete fills shall be clearly furnished in proposal. Bidder shall also indicate whether these are to be manufactured at shop or at site.

7.03.04 PVC firm fill and drift eliminator shall be made of virgin PVC. Black PVC is not acceptable. The PVC fill shall be durable and fire retardant quality. The Bidder shall furnish details of PVC fill along with his offer indicating fire retardant properties, ageing effect, vibration caused by water and wind effects. Frequency of replacement of PVC fills and the method of such replacement shall also be mentioned with above details. The PVC fills shall be of proven quality and the make and its properties shall be subject to Purchaser's approval. The Bidder shall furnish with his proposal, a sample of the fill material to be used for the specified cooling tower.

7.03.05 Design and facing of the fills shall be such as to expose high air/water surface with minimum air pressure drop. Air velocity through the fills shall be uniform.

7.04.00 **Fill Supports**

7.04.01 Splash bar type fills shall be supported on the grids at frequent intervals, preferably not exceeding 450 mm, to minimize sag, possibility of dislodgement, and damage to fill materials as a consequence of induced vibration in the fill.

7.04.02 Only Bottom supported arrangement on RCC is acceptable.

7.04.03 The fill and the support system shall be sufficiently strong to withstand the water loading when the flow path is 30% chocked.

7.05.00 **Drift Eliminators**

7.05.01 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.

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

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

7.06.00 **Access**

7.06.01 Staircases shall be provided external to the cooling tower along with stairways, landings, walkways, handrails and access doors in such number and location as necessary to give safe and convenient access to the top and the interior parts of the tower.

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

7.06.03 Whether specifically mentioned in the Data Specification Sheet or not, steel components and fittings used in walkways, handrails shall be hot dip galvanized after fabrication.

7.07.00 **Cooling Tower Basin & Outlet Sumps**

7.07.01 The hot water distribution basin and cold water outlet channel of the cooling towers shall be designed by considering a minimum of 10% margin over the design cooling tower flow.

7.07.02 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.

7.07.03 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.

7.07.04 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.

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

7.07.06 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.

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

7.08.00 **Screens & Isolating Devices in Cold Water Outlet Sumps, Valves and Pipes in Sludge Pits and Accessories**

7.08.01 Screens in cold water outlet sumps shall consist of 12 mm dia. rods placed at 50 mm centers and mounted on a substantial frame with intermediate support members as necessary. Components for the screen shall be galvanized steel or superior as mentioned in Data Specification Sheet. Guides for the screens to be embedded in the concrete shall preferably be C.I. as per IS: 210 or equivalent. Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

7.08.02 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and push type trolley for mounting the hoist shall be furnished, if asked for in the Data Specification Sheets. The chain pulley hoist shall be manually operated and shall conform to IS: 3832, Class-2.

7.08.03 Sluice gates or Butterfly valves in cold water outlet sumps shall be provided as mentioned in Data Specification Sheet. Sluice gates shall be as per appropriate class of IS: 3042. Butterfly valves shall conform to AWWA C-504 (latest revision).

All mild steel parts shall be galvanized or painted with epoxy enamel primer & paint. The sluice gate may be rectangular or circular as per preference of the Bidder.

The sluice gates/Butterfly valves shall be complete with head-stock for manual operation. The head-stock shall have pillar, base plate and hand wheel made up of cast iron. The head-stock shall have rising/non-rising spindle with position indicator.

7.08.04 The flow area through each gate/valve and screen shall be such as to maintain a flow velocity through them within 1.2 M/sec during the rated flow from cooling tower, with the minimum water level in the cold water basin.

7.08.05 The isolating valves in sludge pits shall conform to appropriate class of IS: 780. Each valve shall be complete with pedestal type manual operator, with rising/ non-rising spindle and valve position indicator.

7.08.06 The pipe spools, to be embedded in sludge pit for piping connection, shall be C.I. pipe as per IS: 1536, Class-LA, unless otherwise mentioned elsewhere.

7.09.00 **Hardware**

All nails and fastening bolts, nuts & washers used in the cooling tower shall be hot dipped galvanized steel, brass or stainless steel, if not specified in the Data Specification Sheet.

8.00.00 CIVIL AND ALLIED WORKS

8.01.00 The civil design and construction of the cooling tower shall be in accordance with the following technical specifications and the Data Specification Sheets enclosed with this specification –

a) Earthwork in Excavation and Backfilling.

b) Cement Concrete (Plain and Reinforced).

c) Masonry and Allied work.

d) Finish to Masonry and Concrete.

e) Metal doors, windows, ventilators, louvers etc.

f) Roof water proofing, insulation and allied work.

g) Painting, white washing, polishing etc.

h) Sheet work in roof and siding.

8.02.00 The technical specifications are of general nature. Only those portions of the specifications which relate to the various works required to be done as per the technical requirements as specified in the tender document need to be considered.

8.03.00 The Cooling Tower shell, ring beams, diagonal columns at base supporting the ring beam below shell, cold water basin, fill support frame work, hot water distribution duct, cold water channel, louver etc. shall be cast-in-situ RCC construction.

8.04.00 Hot water distribution basin/trough/channel at top shall be covered by removable precast concrete slab to prevent direct exposure from sunlight. Corners of pre-cast concrete slabs shall be protected by angles. Lifting lugs shall also be provided for handling of concrete slabs.

8.05.00 The R.C.C. structure of the Cooling Tower shall be painted on the exterior surface with two (2) coats of cement paint like "Snowcem" or approved equivalent.

8.06.00 The interior surface of the Cooling Tower structure and the interior face of the Cooling Tower Basin shall be painted with one coat of primer and two coats water proof bituminous paint conforming to IS:3384 and IS:9862 respectively.

8.07.00 One meter wide (plinth protection) around the building/ structure shall be made by the Bidder.

8.08.00 Mix proportion in Cement-sand mortar for brick masonry work shall be 1:6 for 250 mm thick brickwork and cement-sand mortar (1:6) shall be used for 125 mm and 75 mm thick brickwork.

8.09.00 Thickness of 1:6 cement-sand plaster on brick masonry shall be 18 mm for outside, 12 mm for inside and thickness of 1:4 cement-sand plaster shall be 6 mm for ceiling.

8.10.00 PVC water stops shall be provided at construction/ movement joints of water retaining structures.

8.11.00 The M.S. Pipe hand rails shall be at least one (1) meter high with an intermediate member at 550 mm height. The Posts shall be at 1500 mm spacing. The posts and runners shall be minimum 40 nominal dia and all welded construction with round corners. The tube shall be as per IS: 1161 (for structural purpose) or equivalent. Handrails shall be hot dipped galvanized after fabrication.

8.12.00 All concrete work for the cooling tower shall comply with the requirements given in technical specification for Cement Concrete (Plain & reinforced)

Ordinary Portland cement Grade 53 complying with IS:12269 shall be used in concrete works for all structures and foundations. For PCC, paving and plinth protection works, OPC Grade 43 shall be used.

Fine and coarse aggregate to be used in cement shall comply with IS-383.

8.13.00 Plain mild steel reinforcing bar shall conform to IS: 432 grade I quality and high yield strength deform bars (TMT) shall conform to IS: 1786 (Fe-500).

8.14.00 All structural steel members shall conform to IS: 2062 (GR-A). All exposed steel work shall be protected by hot dip galvanizing. The minimum coating shall be 1000 gm/sq. meter and shall comply with IS: 2629, IS: 2633 and IS: 4759. Galvanizing shall be followed by the applicator of an etching primer and painted with black bitumen in accordance with BS: 3416.

8.15.00 Materials for precast concrete components including joint fixing, lifting hooks and other exposed steel components shall conform to technical specification and other points mention in the document.

8.16.00 Materials, design, construction and workmanship of pre-stressed concrete members shall be in accordance with IS: 1343. Pre-stressing steel wire shall conform to IS: 1785 (Part-I).

The bidder shall furnish a write-up for the method to be used for pre-stressed concrete structures.

8.17.00 The cold water basin walls and floor slab, outlet channels shall be of un-cracked reinforced concrete construction. The design and construction of these water retraining structures shall be in accordance with IS: 3370 (Parts I to IV) with adequate provision of construction / contraction and expansion joints.

The basin floor shall be cast in alternate bays in chequered pattern with sides not exceeding 4.5 meter. The basin and channel walls shall be designed for a surcharge load of 20 KN/sq. m. The basin shall be checked for buoyant condition. No pressure relieve valve to be used.

The construction of the basin and channel shall be water tight with provision of 230 mm (min) wide approved quality PVC ribbed water stop with central bulb at all joints. At expansion joints 230 mm (min) wide PVC water stop shall also be provided.

The water retaining RCC structures shall be tested for water tightness in accordance with IS: 3370 without the backfill to the satisfaction of the purchaser.

The profile of the tower shall be hyperboloid in vertical section and circular in plan. The thickness of tower shell shall be minimum 175 mm.

8.18.00 Reinforcement shall be provided on each face of the shell in both directions and not in a single layer of reinforcement at the centre of the shell thickness. Not more than one third of reinforcement at any level of section shall be lapped.

8.19.00 The form work for shell shall be capable of adjusting to shell profile and thickness accurately, and rigidly braced to prevent deflection or movement during concreting.

The form work shall be rigid, shape preserving, tight fitting and easy to construct so as to ensure smooth concrete surfaces, no geometrical discontinuities and achieve a high degree of dimensional accuracy.

8.20.00 The shell shall be constructed within the dimensional tolerances as stipulated in clause 7.3 of IS: 11504.

8.21.00 The minimum factors of safety for overturning, sliding and hydrostatic uplift shall be 1.5, 1.5 and 1.25 respectively.

8.22.00 The external staircase shall be of reinforced concrete leading to door and giving access to water distribution system.

The stair shall have minimum width of 750 mm with landings of a minimum 1 m length and not more than 2.5 m height intervals. The stair shall have risers not exceeding 175 mm and treads 250 mm minimum.

8.23.00 Reinforced concrete platforms of 1.2 m. clear width shall be provided around the circumference at top of the cooling tower for fixing aviation lights.

12 mm wide radial gaps shall be provided in the platform at suitable intervals for discontinuity.

Adequate MS embedment shall be provided in each side of platform to facilitate maintenance of tower shell.

8.24.00 Walkways shall be provided inside the cooling tower above the fill to provide access for inspection and maintenance of hot water distribution pipes /ducts and nozzles. The clear width of walkway shall be 1.2 m and clear head room shall not be less than 2 m. Walkways shall be designed for minimum live load of 5 KN/sq.m. Radial gaps of 12 mm wide shall be provided at intervals in the walkways for discontinuity.

8.25.00 MS rung ladders shall be hot dip galvanized ladder shall be 600 mm wide fabricated out of 60 mm x 10 mm flats with 20 mm dia. rungs at 300 mm centers. Stays shall be provided at every 2.25 m intervals connecting the ladder with the concrete shell.

Safety cage shall be provided for all ladders and shall be fabricated out of 5 nos. verticals of 50 mm x 6 mm flats with 50 mm x 6 mm flat straps at 800mm centers.

Intermediate landings of reinforced concrete of size not less than 750 mm x 1500 mm shall be provided at every 8 to 10 m height of the ladder.

8.26.00 Data specification sheet and Soil Report (By EPC Contractor) shall be referred to for selecting allowable bearing pressure to be considered in designing the foundation and in selecting depth of foundation.

8.27.00 The bidder has to select suitable type of foundation compatible with the soil strata and calculated settlement of structure and foundation system. The bidder shall have to furnish conceptual design indicating type of foundation, general arrangement drawing for super structure, basin, pipe supports, pits, founding level etc. including settlement criteria complete with a design basis report with the offer.

8.28.00 For every electrical and mechanical equipment and accessories the base plates, foundation plates, anchor bolts, sleeves and inserts shall be provided as necessary for installation on R.C.C. works.

9.00.00 **CIVIL DESIGN BASIS**

9.01.00 The natural Draught Cooling Tower shall be designed for the following loads as per IS 11504 (latest edition) -

a) Dead loads

b) Imposed loads (including construction loads)

c) Wind loads

d) Earthquake loads

e) Thermal loads

9.01.01 **Dead loads**

Dead loads shall include the weight of structure complete with finishes, fixtures and partitions and shall be taken as per IS 875 (Part-1). Dead loads for NDCT shall include self weight of structure, weight of fill materials, weight due to algae growth, weight of falling water, weight of hot water pipe, weight of water in hot water channel and distribution system including the self weight of channel and distribution system, weight of drift eliminators, etc.

9.01.02 **Imposed Loads**

Imposed loads on various structures shall be as follows –

i.	Basin, sump, duct & underground pipe	-	Besides earth pressure under dry and wet condition, an additional surcharge of 2.0T/m2 shall be taken
ii.	Covers for Hot water channels/HW distribution basin	-	0.3T/m2
iii.	Walkway inside CT distributing basin	-	0.3T/m2
iv.	Construction loads		

The Bidder shall decide the method of construction and type of formwork to be used in advance. Temporary loadings likely to be imposed during construction shall also be considered in the design of CT structures. Temporary loadings may include the following depending upon the method of construction –

a) Handling of concrete

b) Scaffolding and formwork

c) Correcting shutter alignment

d) Hoist fixing

e) Storage of materials on scaffolding

f) Temporary access

g) Tower crane fixing

h) Work temporarily omitted for access purposes

9.01.03 **Wind Loads**

a) Basic wind speed (Vb) at 10 M above mean retarding surface shall be taken as per IS 875.

b) Risk coefficient, K1 and topography factor, K3 shall be as per IS 875 (Part-3). K2 shall be as per Table 2 of IS:875 (part-3) 1987.

c) Wind pressure (Pz) at a given height shall be calculated as $Pz = 0.6xVz^2$ where Vz = Vb x K1 x K2 x K3.

d) Wind loading shall be calculated by the gust effective factor (GEF) method as well as by the peak wind method and the higher of the values obtained shall be adopted for final design. While calculating wind load using GEF method, the term 'b' shall be taken as the diameter of the throat in Fig. 10 of IS 875(part 3)-1987.

e) A load enhancement factor of 1.43 shall be applied to the wind loading calculated, to account for:

i. Natural turbulence in the incident wind resulting from the bluff obstructions and wake

ii. Increase in wind speed as well as turbulence induced in the incident wind by adjacent cooling tower and the structures of significant dimensions

iii. Geometrical imperfections of the shell.

f) The wind pressure distribution around the shell at the heights shall be calculated as per the Cosine Fourier expression given in Appendix-A of IS 11504 (latest). The actual design wind pressure is obtained by multiplying the basic wind pressure (Pz) by the coefficient P' (as per Appendix A) and the wind load enhancement factor 1.43.

g) The design shall ensure that the cooling tower shall be free from wind induced oscillations. A damping factor of 1% of the critical damping shall be considered while analyzing the structure for wind induced ovaling oscillations as well as any dynamic phenomenon involving wind effects.

9.01.04 **Seismic Loading**

a) Seismic Zone III as per IS: 1893-Latest shall be considered for evaluating seismic forces.

b) Design against seismic shock requires that structures be designed with sufficient ductility to withstand seismic forces safely without any loss of function or damage of any sort.

c) Equipment, equipment supports and structures shall be designed to withstand seismic forces as represented by applicable horizontal design seismic coefficient.

d) All columns supporting the "packing" / "filling" material shall be adequately braced to cater to the above loading.

e) Modal Analysis using response spectrum method shall be done for designing the tower shell, raker columns and foundations for seismic loads.

9.01.05 **Temperature Loads**

a) For temperature loading, the total temperature variation shall be considered as 2/3 rd of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50 % of the total temperature variation

b) Temperature effects due to solar radiation shall also be considered in addition to above.

c) The cooling tower shell shall be designed for stress due to axi-symmetric temperature distribution corresponding to external ar temperature variation from 0 deg C to 47.5 deg C. However the de analysis of actual thermal gradient by considering temperatures i the tower and external ambient temperatures shall be carried furnishing detailed references and justification for the same.

d) The shell shall also be checked for thermal stresses arising due

partial operation of the tower in case the operational philosophy so demands. The calculation for stress analysis resulting from non-symmetric temperature loading shall be based upon the operating condition.

e) Besides, the shell shall be designed for one sided solar radiation effect also. Nevertheless an effective temperature difference of at least 25 deg C across the shell thickness constant over the height and following a sine function along half the circumference shall be considered.

9.01.06 **Design Load Combinations**
Load combinations shall be as specified in IS: 875 (Part-5)

9.02.00 **Method of Analysis**

a) The complete cooling tower, including the shell, raker columns, and ring beam and foundation system shall be structurally analyzed using a proven finite element modeling software. The design geometric profile, thickness of all structural members and variation in thickness and support conditions of shell shall be considered in the structural analysis. Design of shell shall be carried out using limit state method as per IS 456 with serviceability criteria of crack width limited to 0.1mm.

b) In the design of cooling tower shell, columns, pile caps, pedestals, ring beams, etc., no increase in the strength of concrete with age shall be permitted.

c) Permissible stresses for steel structures shall be as per IS 800 based on working stress method.

9.03.00 **Foundation of Cooling Tower**

a) Cooling Tower including basin shall be provided with suitable foundation system. Grade of concrete for all foundation works and CT basin shall be M-25. Basin shall be checked for uplift forces considering empty condition with ground water table at level as per Geo Technical Investigation recommendation. A minimum factor of safety of 1.2 against uplift shall be ensured for the following conditions-

b) Basin walls constructed up to finished ground level and there is no water in the basin, superstructure columns not constructed and ground water table at finished ground level.

c) No pressure relief valves shall be provided in the cold water basin. The water tightness of the basin shall be ensured to prevent mixing of ground water with sweet water of CW system.

Besides the system requirement, minimum depth of the basins should be fixed in such a way that proper flow of water by gravity up to the C.W. channel is ensured.

9.04.00 Liquid Retaining Structures

a) Design of CT basin (including outer face in contact with earth) sump, outlet channel, duct sludge pit, H.W. distribution basin/ H.W. channel shall be designed as un-cracked section as per IS 3370.

The allowable stresses in concrete and steel for the above structures shall be as per IS 3370. Grade of concrete shall be M-25 for these structures. The CT basin, ducts, sludge pit etc. shall be designed for the following conditions –

i) Water filled inside upto the designed level and no earth outside

ii) Earth pressure plus 2T/m2 surcharge outside and no water inside, ground water table at finished ground level.

iii) For safety against uplift, factor of safety shall be min. 1.2

b) The water tightness of CT basin, outlet channel, hot water channel and all other water retaining structures, shall be tested as per the provisions of IS 3370.

9.05.00 Shell Analysis and Design

a. Shell shall be designed as per Clause 6.3 of IS 11504 (latest) by proven software. Concrete Grade for shell shall be M-30 (minimum)

b. Bending analysis shall be carried out for the shell using finite element method.

c. The boundary conditions shall be as outlined in Clause 6.3.1 of IS 11504 (latest).

d. The shell analysis should include following information at 10° plan angle and of not more than 0.05 of the shell height:

i. Meridional and circumferential direct stress, resultants and the tangential shear stress resultants.

ii. Meridional and circumferential bending moments.

iii. Displacements normal to the shell mid surface.

e. Provisions of IS:2210 (latest) "Criteria for the design of reinforced concrete shell structures and folded plates" and IS:2204 - 1962 "Code of practice for construction of reinforced concrete shell roof" shall also be applied to the design and construction of cooling tower shells wherever they are not covered above. All other design criteria for the cooling tower shell which are not specified above shall be in accordance with BS:4485 (latest edition, relevant part) except wherever reference is made to other British Codes relevant Standard Codes shall be followed.

f. Secondary stresses, if any due to permanent fixtures on the shell s be investigated.

9.06.00 Buckling Of Tower Shells

a) Critical dynamic wind pressure at buckling shall be as given below:

$$Pcr = 0.07\, E_c \frac{(d)^{7/3}}{(r_{th})^{7/3}}$$

Pcr = Critical dynamic pressure

E_c = Modulus of elasticity of concrete of the shell (short term modulus)

d = Thickness of the shell

r_{th} = Throat radius of the shell

b) The shell buckling shall be checked using the design dynamic wind pressure and other relevant loads acting on the tower. The factor of safety against buckling shall be not less than 5 for the completed tower and as well as under construction condition.

9.07.00 Openings In Shells

a) Opening through the shells should be avoided as far as possible. They should be of smallest required dimensions and shall be shaped such that stress concentration is minimized at the boundary of the opening. Should thickening of the edges be necessary, it shall be smoothly tapered back to the shell thickness.

b) Openings in shell shall preferably be at right angles to the middle surface of the shell to avoid acute angled edges to the openings.

c) Openings shall be provided with additional edge reinforcement of a minimum cross sectional area at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition, diagonal reinforcement shall be provided at each corner as close as possible.

The total cross-sectional area in cm^2 of this reinforcement shall be 0.5d, at each corner where'd' is the shell thickness in cm.

d) No horizontal thrust due to the inlet piping shall be transmitted to the shell.

9.08.00 Minimum Reinforcement in Shell, Spacing And Placement

a) The reinforcement used shall be cold worked steel high strength deformed bars (TMT) of grade Fe500 conforming to IS: 1786 - latest. The minimum reinforcement to be provided shall be as follows:

Top one third portion of shell	0.4% concrete cross- sectional area along circumferential direction and 0.35% of concrete cross – sectional area along meridional direction
Remaining two-third portion	0.35% of concrete cross sectional area in both meridional and circumferential directions.

b) Minimum bar diameter shall be 8mm in transverse direction and 10mm in meridional direction

Spacing of reinforcing bars should not exceed 200 mm in circumferential direction and 250 mm in meridional direction.

The two layers of reinforcing meshes shall be adequately joined by S-hook over the total shell surface. At least two S-hooks in each square meter area of shell surface shall be provided. The hooks shall be of minimum 6mm diameter bars.

The concrete cover shall be 50 mm minimum. However, the clear cover shall not be less than 1.5 dia. of bars.

c) Provision of meridional ribs in Cooling Tower Shell

Meridional ribs in cooling tower shell may be provided subject to the following conditions:

Minimum thickness of shell excluding ribs shall not be less than 175mm.

Coefficients for pressure distribution around the cooling tower circumference including suction may be taken as per VGB-BTR KUCHLTURMEN GERMAN SPECIFICATIONS (latest).

All other factors including load intensification factors shall be as specified elsewhere in this specification.

Shell buckling and strength shall be checked as per Clause-9.06.00 above without considering the effect of ribs.

All other stipulations as specified in this specification shall be met with.

Bidder shall furnish an authorized English translation of the VGB-BTR KUHLTURME GERMAN SPECIFICATIONS (latest).

d) As the range of possible hyperbolic shell shapes is infinite, the design shall be confined to the following major proportions, which have been extensively adopted in cooling tower constructions.

H/D = 1.2 to 1.55 where H is the total tower height above basin sill level

H_b/H = 0.75 to 0.85 — H_b is the vertical distance from the throat to basin sill level and 'D' is the base diameter at basin sill level

e) Checking of shell geometry and tolerances shall be as per Clause 7.3 & 7.4 of IS 11504 (latest)

9.09.00 Raker Columns

a) The dead weight of the integral shell and wind or seismic forces induced in it shall be transmitted to the foundation system through a series of raker columns spanning air intake openings. Inclination of the raker columns shall closely match the meridional slope of the shell so that load transfer to foundation takes place through predominantly axial force in columns. Raker columns shall be designed for the most critical forces transferred to an individual rake column from superstructure considering various load combinations. Raker Columns shall be of Grade M-35

9.10.00 **Supporting structures for packing, platforms, internal grillage/fill supports**

a) Such structures shall be designed as per Clause 6.5 of IS 11504 (latest) and shall be of Grade M-25 except fill support columns and beams. Fill support columns and beams shall be of Grade M-35. Apart from self weight and imposed loads, design of fill support structures shall be done considering weight of falling water and weight of minimum 5mm thick sludge deposit/moss.

9.11.00 Fittings and fixtures

a) Complete system of Lightning protection, Aviation warning lights and Access ladder to be provided as per Clause 7.5 of IS 11504 (latest).

10.00.00 ELECTRICAL ITEMS

Refer Volume-II F2, Section-XV

11.00.00 **TESTING AND INSPECTION**

11.01.00 **Test at Manufacture's work**

11.01.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and shall be in compliance with requirements of applicable codes and standards.

11.01 02 The particulars of the proposed tests and the procedures for the tests shall be submitted to the Purchaser/Consultant for approval before conducting the tests.

11.01.03 Inspection shall be conducted by the manufacturer to establish and maintain quality of workmanship, to ensure mechanical accuracy of components, compliance with drawings, identity & acceptability of all material, part and equipment. Where specified, all such Inspections shall be conducted in presence of Purchaser's representatives.

11.01.04 The Bidder shall submit to the Purchaser/Consultant at the initiation of the contract, the detailed bar chart showing the manufacturing program and indicating the period when Purchaser or his authorized inspecting agency are required at the shop for inspection and/or testing. Also, the manufacturer shall intimate the Purchaser 3 to 4 weeks in advance of such tests. The Purchaser/Consultant shall be given full access to all tests and inspection.

11.01.05 All materials used for cooling tower construction shall be of tested quality. Materials shall be tested as per the relevant standards or codes and test certificates shall be made available to the Purchaser/Consultant.

11.01.06 Where stage inspection is specified, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by Purchaser's inspector who shall stamp the material. In case mill test certificates for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by the Purchaser, as per the requirements of specified material standard. The samples for physical and chemical testing shall be drawn up in presence of Purchaser's inspector who shall also witness the testing.

11.01.07 Hydrostatic testing for hot water distribution piping shall be at a pressure of 200% of design pressure after fabrication at shop.

11.01.08 Butterfly valves shall be tested as per the stipulations of AWWA C- 504, latest edition.

11.02.00 **Tests at Site**

11.02.01 After completion of erection and commissioning of the cooling tower, performance test of the cooling tower shall be carried out as specified in Data Specification Sheet in accordance with Cooling Tower Institute Bulletin No. ATC-105 "Acceptance Test Procedure for Water Cooling Tower" or ASME (USA) performance test code PTC: 23 or other equivalent mutually agreed method. The details of the proposed test procedure shall be submitted by the supplier sufficiently in advance of the commencement of test for the review and approval of the Purchaser.

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

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

12.00.00 PERFORMANCE GUARANTEES

12.01.00 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.

12.02.00 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.

12.03.00 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.

13.00.00 DRAWINGS/DOCUMENTS, DATA & INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH THE TECHNICAL OFFER

13.01.00 The Bidder shall furnish along with his proposal following specific drawings/documents/data as asked for in this section.

13.01.01 General arrangement drawing for cooling tower, incorporating all relevant dimensions, material of construction of different parts, limits of scope of supply of piping, limits of civil-works included, basin details indicating overflow and de-sludging arrangement, arrangement of staircase, ladders, platforms, lightning protection system, Aviation obstruction lightning system of cooling tower etc.

13.01.02 Predicted performance curves, showing wet bulb Vs. cold water temperatures for design cooling range, 85% cooling range and 115% cooling range. Such curves shall be furnished for 85%, 100%, 115% flow. In case more than one operating point is specified, all above details/curves are to be furnished corresponding to all additional operating points also.

13.01.03 Cooling Tower Manufacturer's detailed literature including drawing and diagram for :

a) Tower fills with supporting arrangement.

b) Drift eliminator.

c) Complete distribution system including regulating type water distribution valves, distribution basin/pipes, orifices/ nozzles, etc.

13.01.04 Electrical power distribution scheme.

13.01.05 A detailed experience list about supply of similar plant by the Bidder/ Manufacturer and his collaborator.

13.01.06 A comprehensive write-up or Brochure on the details of manufacturing and testing facilities in the shop of Manufacturer.

13.01.07 All other relevant data and drawings as asked for in the specification and as required.

13.01.08 A sample of the fill material to be used for the specified cooling tower.

13.01.09 Bidder's proposal covering chemical treatment of cooling water to minimize biological fouling, scaling and corrosion as well as for containing concentration factor.

14.00.00 **DRAWINGS/DOCUMENT, DATA, AND MANUAL TO BE FURNISHED AFTER AWARD OF CONTRACT**

14.01.00 Final version of all drawings/data/informations asked for in clause 13.00.00 above.

14.02.00 The following drawings shall be submitted within a reasonable time after placement of order :

14.02.01 General arrangement of the cooling tower, indicating all principal dimensions, extent of platforms, walkways, handrails, stairs, doors, illumination, arrangement of cooling tower structure and limits of supply and erection of piping, electrical and civil works.

14.02.02 Arrangement drawing of the cold water sumps and sludge pits for the cooling tower, incorporating also arrangements of screens, sluice gates, butterfly valves, gate valves, piping, and monorail chain pulley block installation, etc.

14 02.03 Performance curves as described in Clause 12.01.02.

14.02.04 Following drawings on mechanical equipment, their drives and accessories:

i) Fabrication and piping erection drawing.

ii) Outline and sectional drawings of valves of each category indicating also material of construction.

iii) Drawing on fill, drift eliminator and its support systems and fastening arrangement complete with data on material of construction.

iv) Drawing on splash boxes, nozzles in hot water basin, with data on material of construction.

v) Drawings on screens & gates with material of construction.

14.02.05 Electrical Drawings and Data as specified in Volume-II F2, Section-XV.

14.02.06 Detail technical particulars of equipment and materials under the scope of specification.

14.02.07 Drawings, Data and Calculation on Civil works

i) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of the cooling tower inclusive of pre-stressed concrete fill where applicable.

ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.

iii) Civil drawings for cold water basin, connecting channels, partitions, louvers, end walls, longitudinal beams, hot water distribution basin, its covering, staircase, platforms, cable trenches, etc. all complete.

iv) Bar bending details for all reinforced concrete structures.

v) Insert details, anchor bolt details.

vi) Final painting schedule.

vii) Other drawings & data as necessary.

14.03.00 The Documents to be submitted before dispatch of Equipment for approval

14.03.01 Material Test Certificate for mechanical equipment.

14.03.02 Certificates on treatment done on timber components.

14.03.03 Test certificates on each electrical equipment, cables and accessories.

14.03.04 Instruction Manuals

i) The Instruction Manuals shall present the following basic categories of information in practical, complete and comprehensive manner prepared for use by operating and/or maintenance personnel :

- Instruction for initial installation of mechanical and electrical equipment.
- Instructions for operation, control, monitoring and protection.
- Instruction for maintenance, overhaul and replacement of parts etc.
- Recommended inspection points & periods of inspection.
- Lubrication Chart.
- Ordering information for all replaceable parts, etc.
- Write-up, leaflet/catalogue etc. covering equipment features.

ii) The information shall be organized in a logical and orderly sequence. A general description of the equipment including significant technical characteristics is required to familiarize operating and maintenance personnel with the equipment.

iii) Necessary drawings and/or other illustrations shall be included or copies of appropriate certified drawings shall be bound in the manual. Test, adjustment and calibration information, as appropriate, shall be included and shall be identified to the specific equipment. Safety and other warning notices and installation, maintenance and operating cautions shall be emphasized.

iv) A parts list shall be included showing part nomenclature, manufacturer's part number and/or other information necessary for accurate identification and ordering of replacement parts.

v) Instruction and part list shall be legible and prepared on good quality paper.

vi) The Instruction Manual shall be securely bound in durable folder.

vii) If a standard manual is furnished covering more than the specific equipment purchased, the applicable model (or other identification) number, part number and other information for the specific equipment purchased shall be clearly identified.

viii) The Instruction Manual shall include list of all special tools and tackle furnished with complete drawing and instruction for use of such tools and tackle.

ANNEXURE-A

DATASHEET FOR NATURAL DRAFT COOLING TOWER

1.0 General Information

Type of Cooling Tower	:	Natural Draft, Hyperbolic
No. of Cooling Towers Required	:	One
Location	:	Outdoor
Duty	:	Continuous

2.0 Design Working Conditions

Hot water inlet temperature	:	42.5°C
Design Ambient wet bulb temperature	:	28°C
Design Ambient temp. for electrical equipment	:	50°C
Design Ambient Relative Humidity	:	65%
Whether inlet air wet bulb temperature to be corrected considering re-circulation as per CTI bulletin PFM-116	:	Yes
Design CT inlet wet bulb temperature	:	By Bidder
Basin Holding Capacity	:	6 mins of design CT capacity
Design Wind speed	:	By Bidder

3.0 Performance Requirement

Rated Cooling Water flow	:	By Bidder
Cooling range	:	9.5°C
Approach to ambient wet bulb temperature	:	By Bidder
Maximum permissible drift loss	:	Very close to 0%
Design pressure for hot water distribution system	:	By Bidder
Operating range to be established by cooling tower characteristics curves and performance curves	:	As per Clause no. 5.03.00

4.0 **Special Features**

Type of Tower design.	:	Counter-flow / Cross-flow (Bidder to justify his offer)
Type of fill	:	Film/Splash (Bidder to justify his offer)
Whether fills are removable type	:	Yes

5.0 **Material of Construction**

Cold water basin, outlet channel/sump & sludge pit	:	R.C.C.
Casing & superstructure	:	R.C.C.
Basin diagonal partition, if any	:	R.C.C.
Staircase	:	R.C.C./HDG Steel
Hot water distribution piping		
• Inside Tower	:	HDG Steel/PVC
• Outside Tower	:	MS pipes with PVC/FRP Wrap on outside.
Hot water distribution nozzles	:	Polypropylene/Approved Equal
Fills	:	PVC with minimum spacing of 20 mm
Fill Support	:	R.C.C./HDG Steel
Louvers	:	R.C.C.
Drift eliminator	:	PVC
Hot water piping	:	IS: 3589
Butterfly valve for hot water distribution system/cold water outlet channel	:	
• Body	:	CI as per IS-210, FG-260
• Disc	:	- do -
• Shaft and spindle	:	SS304 as per ASTM A-479
• Shaft bearing	:	Leaded bronze, self lubricated (BS-1400, LB-2)

• Seat ring	:	ASTM A-479, Type 304
• Gland packing	:	Impregnated Teflon
• Seal	:	Nitrile Rubber, Shore Hardness 50-60 Deg.
• Bolts & Nuts (in contact with water)	:	Stainless Steel Sludge pit isolation valves:
• Body	:	CI IS-210, FG-260
• Spindle & Trim	:	Stainless Steel.
• Sludge outlet pipe	:	CI IS-1536, LA
• Screen	:	Anodised Aluminium
• Guide for screen	:	CI IS-210, FG-260
• Bolts, nuts & other hardware	:	Stainless Steel

6.0 Inspection And Testing

Quality surveillance by	:	Manufacturer/Purchaser
Material testing and identification	:	Required
Stage inspection to be witnessed by Purchaser	:	Yes
Hydrostatic test for piping & valves required	:	Yes
Hydrostatic test to be witnessed by Purchaser	:	Yes
Field performance test of individual items and the cooling tower as a whole required	:	Yes
Field performance test to be done by	:	Manufacturer/EPC Contractor
All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
All testing instruments by supplier	:	Yes
Commissioning at site by	:	Manufacturer/EPC Contractor

SECTION – C2

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

WANAKBORI TPS UNIT-8, (1 X 800 MW)

TECHNICAL SPECIFICATION

FOR

NATURAL DRAFT COOLING TOWER

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

c) Supply of mandatory spares as specified in the specifications of mechanical equipment.

d) Erection and commissioning spares.

e) Erection & Maintenance tools & tackles.

f) Electrical load requirement for NATURAL DRAFT COOLING TOWER.

g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.

i) Various drawings, data sheet as per required format, quality plans, calculations, Type test & Routine test reports & certificates, operation and maintenance manuals, Complete technical literature with catalogues etc shall be furnished as specified at contract stage. All documents shall be subject to customer /BHEL approval without any commercial implications to BHEL.

j) Motor shall meet minimum requirement of motor specification.

k) LT power & control cables shall meet minimum requirement of LT power & control cables specification.

l) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

m) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

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

a) A copy of this sheet "Electrical Equipment Specification for NATURAL DRAFT COOLING TOWER" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.

b) List of Erection and Commissioning spares.

c) List of Erection & Maintenance tools & tackles.

d) Electrical load requirement.

e) If there is any conflict, customer motor specification will prevail over BHEL motor specification.

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

4.0 LIST OF ENCLOSURES

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

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

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

PROJECT : 1 X 800 MW WANAKBORI TPS EXTN. UNIT – 8

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

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

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

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

NOTES:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

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

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

2. All QPs shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

3. In case the requirement of Junction Box arises on account of Power Cable size mismatch due to vendor's engineering at later stage, vendor shall supply the Junction Box for suitable termination.

4. Wherever BHEL is indicated above, if the scope of supply and E&C of any of the above listed items is in BHEL's Customer scope, then the respective items shall be supplied, erected and commissioned by BHEL's Customer. For such items, BHEL as indicated in SUPPLY and E&C column above shall be read as "BHEL's CUSTOMER".

VOLUME : IIF/2

SECTION-XV

TECHNICAL SPECIFICATION
FOR
~~CHIMNEY &~~ NATURAL DRAFT COOLING TOWER
- ELECTRICAL WORKS

CONTENTS

SECTION : XV

TECHNICAL SPECIFICATION
FOR
~~CHIMNEY~~ & NATURAL DRAFT COOLING TOWER
- ELECTRICAL WORKS

1.00.00 INTENT OF SPECIFICATION

1.01.00 The intent of this specification is to broadly specify all electrical equipment, system and works related to aviation obstruction lighting, functional power and lighting, lightning protection and grounding as required for ~~chimney &~~ Natural Draft Cooling Tower for 1x800MW Supercritical TPP at Wanakbori, Gujrat. All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in the relevant standards.

2.00.00 SCOPE OF WORK

2.01.00 The scope of supply and services shall include but not be limited to the following for ~~Chimney &~~ Natural Draft Cooling Tower :

a) Equipment and materials as required.

b) All relevant drawings, data and instruction manuals.

c) Recommended spares for three (3) years of operation.

d) Erection, testing and commissioning of all electrical equipment and materials supplied under this specification.

e) Obtaining statutory approvals for Aviation warning system from concerned authority.

2.02.00 ~~Chimney &~~ Natural Draft Cooling Tower shall be provided with but not be limited to the following :

a) Normal and Emergency Power distribution and control system

b) Electrical system for chimney Elevator

c) Aviation Obstruction Lighting system

d) Normal and Emergency Lighting system

e) Cabling and conduit system

f) Earthing system

g) Lightning protection system

h) All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary.

2.03.00 **Power Supply**

2.03.01 Contractor shall manage the following power supply for ~~Chimney &~~ Natural Draft Cooling Tower including supply, laying and termination of the cable for the below power supply :

~~a)~~ One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz ± 5% (fault level 50 KA) supply to AC Distribution Board for Normal AC Lighting and elevator for Chimney.

b) One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz ± 5% (fault level 50 KA) supply to AC Distribution Board for Normal AC Lighting for Natural Draft Cooling Tower.

~~c)~~ One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz ± 5% (fault level 50 KA) supply from emergency source to Lighting board for Emergency lights and Aviation Warning Lights and elevator for Chimney.

d) One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz ± 5% (fault level 50 KA) supply from emergency source to Lighting board for Emergency lights and Aviation Warning Lights for Natural Draft Cooling Tower.

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

3.00.00 **DISTRIBUTION BOARD**

3.01.00 **AC Distribution Board**

AC distribution board (ACDB) shall be provided for feeding lighting distribution boards, elevator and power receptacles. This AC distribution board shall be located at EL 0.0 m of Natural Draft Cooling Tower ~~& inside the concrete shell of the chimney~~. The incoming to the ACDB shall be suitable for 415V, 3 phase, 4 wire, 50 Hz supply. 10% spare feeders with minimum one (1) of each type and rating shall be provided.

3.02.00 **Lighting Board**

~~One (1) lighting board shall be provided for Normal A.C. Lighting and one (1) Lighting board shall be provided for Emergency A.C light and Aviation Warning lighting system for chimney~~. Similarly One (1) lighting board shall be provided for Normal A.C. Lighting and one (1) Lighting board shall be provided for Emergency A.C light and Aviation Warning lighting system for Natural Draft Cooling Tower. These lighting boards shall also be located at El. 0.0m. Each lighting distribution board shall be provided with an adequately rated dry type, delta/star, lighting transformer with Z not more than 5% and off circuit taps for variation from (-5%) to (+)5% in steps of 2.5% on the primary side. The star point of the secondary side shall be solidly grounded to get the 3 phase, 4 wire supply required for the lighting distribution board. The lighting

distribution boards shall have 10% with minimum two (2) spare feeders of each type and rating.

The dry type transformer shall have the following properties :

i) Insulation class of lighting transformer shall be “F”

ii) Temperature rise shall be limited class “B”.

iii) The transformer shall be cast resin type.

3.03.00 **AC Distribution Board / Lighting Board Constructional Details**

3.03.01 AC Distribution Board (ACDB) and Lighting Boards shall be metal enclosed, fabricated from CRCA sheet steel minimum 2 mm thick. AC Distribution Board shall be modular construction, fixed type module, floor-mounted and free-standing type. Each module of ACDB shall be provided with hinged door. Lighting Boards shall be suitable for either wall/column mounting on brackets or floor mounting on channel sills with hinged door on the front.

3.03.02 AC Distribution Board and Lighting Boards shall be dust and vermin-proof, IP-54 or better.

3..03.03 AC Distribution Board and Lighting Boards shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

3.03.04 AC Distribution Board and Lighting Boards shall have provision of cable entry from bottom as required, with removable gland plates. Necessary double compression type brass cable glands, heavy duty tinned copper cable lugs (for aluminium and copper conductor) shall be furnished by the Contractor.

3.03.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on AC Distribution Board and Lighting Boards for connection to 75mmx10mm G.I. flat.

3.03.06 AC Distribution Board shall be complete with designation and caution notice plates fixed at front and back side and feeder name plate fixed on the front cover. Each Lighting Board shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of the circuit.

The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

3.03.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85 Deg.C.

3.03.08 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

3.03.09 AC Distribution Board shall consist suitable rated MCCB for over load and short circuit protection for incomer, voltmeter with selector switch and suitable PT, C.T. operated ammeter. Outgoing feeder from the AC Distribution Board

shall also have MCCB with a over load and short circuit release. It is the Contractor's responsibility to ensure proper discrimination between outgoing MCCB of AC Distribution Board and downstream MCCB of Lighting Boards.

3.03.10 Each Lighting Board shall have an incoming triple pole MCCB with neutral link with over load and short circuit release., Lighting transformer and a number of outgoing miniature circuit breakers (MCB), 9 KA rating. The lighting transformer shall be dry type housed in the cubicle.

3.03.11 Access door of AC Distribution Board and Lighting Board shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.

3.03.12 MCBs (9 KA rating) in Lighting boards shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

3.03.13 AC distribution board and lighting boards, after application of primer, shall be finished with electrostatic or powder painting process (thickness not less than 50 microns). The colour of exterior shade shall be light gray (RAL 7032).

4.00.00 AVIATION OBSTRUCTION LIGHTING FOR ~~CHIMNEY AND~~ COOLING TOWER

4.01.00 ~~Illumination System for Chimney~~

4.01.01 Aviation Obstruction Lighting System

Aviation obstruction lighting system will conform to requirements of the latest Indian Standard, the International Civil Aviation Organization (ICAO), the instruction issued by the Director General of Civil Aviation – India and the Directorate of Air Routes & Aerodromes' (DARA) Circular.

In confirmation to tender specifications and clause no. 6.3.8 of Annex-14 of ICAO, high intensity type'A' white flashing XENON lights will be provided. AWLs will be provided at 2 levels at E.L.271.0m (with considering the Chimney height 275m)and 185.0m & Medium intensity type 'B' Red Flashing LED at 105.0m in conformation to the clause no. 6.3.19 of Annex-14 of ICAO, which says vertical intervals shall not exceed 105.0m. Three (3) nos. of lights will be provided at each level spaced 120^{o} apart, confirming cl.no.6.3.11 & 6.3.22 of Annex-14 of ICAO. AWLs will be installed with the setting angles as specified in 6.3.21 of Annex-14 of ICAO i.e.2^{o}at EL105.0m & 0^{o} at other levels. A common flasher with flash frequency of 40 flashes per minute will be provided in aviation control panel, such that all AWLs flashes simultaneously as per cl. 6.3.35 of Annex-14 of ICAO.

AWLs at EL 271.0 are provided with 1.0m vertical projections and hence the light beam level is below the steel flue top by 3.0m in confirmation with cl.6.3.12 of Annex-14 of ICAO. Aviation painting is omitted as per cl.no.6.1.4c of Annex-14 of ICAO.

All AWLs are distributed over 3 phases such that failure of any one phase would not blank any face of chimney i.e R-Y-B, Y-B-R & B-R-Y arrangement.

Aviation control panel is provided with photoelectric switch that operates intensity step changer as under.

Ambient	North sky illuminance (Lux) Step changer operating range	AWL intensity Cd
Night to Twilight	21.5 < >53.6	From 2000 to 20000
Twilight to Day	377< >646	From 20000 to 200,000
Day to Twilight	377< >646	From 200,000 to 20000
Twilight to Night	21.5 < >53.6	From 20000 to 2000

Temporary obstruction lighting will be provided during construction. Obstruction lights will be provided at the uppermost part of the stack or the surrounding scaffolding as construction proceeds upwards. As such level specified to have permanent obstruction lights is passed, that level will be provided with temporary lighting.

4.01.02 **~~Temporary Obstruction Lights~~**

The EPC Contractor shall provide at two(2) lights located at diametrically opposite points at the top of the chimney during the period of construction till the permanent obstruction lights are installed and energized, to serve as temporary obstruction lighting.

4.02.00 **Illumination system for Cooling Tower**

4.02.01 Aviation Obstruction Lighting System

Aviation obstruction lighting system conforms to the requirements of the latest Indian Standard, the International Civil Aviation Organization (ICAO), the instruction issued by the Director General of Civil Aviation – India and the Directorate of Air Routes & Aerodromes' (DARA) Circular No. 3 of 1987.

White flashing high intensity LED lights of Type 'A' of table 6.3, Annex-14 of ICAO guide lines shall be provided on top of cooling tower. Six numbers of AOLs shall be provided. All AOLs are distributed over 3 phases.

Aviation control panel is provided with photoelectric switch that de-activates and activates the circuit depending on north sky luminance.

Temporary obstruction lighting will be provided during construction. Obstruction lights will be provided at the uppermost part of the tower or the surrounding scaffolding as construction proceeds upwards. As such level specified to have permanent obstruction lights is passed, that level will be provided with temporary lighting.

The aviation obstruction lights shall meet the recommendations of ICAO and all the requirement of Director General of Civil Aviation, India. Aviation lights shall be fixed only on top of cooling tower. Type of fixtures shall be as listed below.

4.03.00 The illumination system of chimney and cooling tower is governed by DCGA guidelines. In case of any changes in the guidelines in future, the same shall be adhered to.

4.04.00 **Aviation Obstruction Light Fixtures (AOL Fixtures)**

4.04.01 Each AOL fixture shall have 100% standby light i.e. twin type. Incase of failure of one light, the standby should be activated automatically with auto changeover facility giving hooter feed back. AOL shall be L.E.D type for low and medium intensity and Xenon type for high intensity lights. The degree of protection shall conform to minimum IP 55 grade protection class. High intensity lights shall have intensity step changers.

The control panel for the AOLs shall be mounted near the main distribution board at ground level.

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

5.00.00 **INTERIOR AND EXTERIOR LIGHTS**

5.01.00 Interior platforms and staircase shall be illuminated by PHILIPS type NDC 21 or equivalent industrial well glass luminaries with 150 W HPSV lamp and separate control gear box. The number of fixtures shall be selected based on an illumination level of 70 lux for the staircase and platform. Fixture and control gear shall conform to degree of protection IP55 (min.).

At least two (2) fixtures on each platform level shall be fed from aviation warning lighting board (emergency source). All staircase lights shall also be fed from emergency system.

5.02.00 Necessary junction boxes with MCBs shall be provided on each platform to control the platform and staircase lights.

5.03.00 One (1) 15A, 240V, single phase industrial, weatherproof type, suitable for wall/ column mounting, 3-pin receptacle with suitable interlock shall be provided on each internal and external platforms. At least two 63A, 415V, three phase industrial, weatherproof type, 5-pin receptacles shall be provided at the internal platforms.

5.04.00 **~~Chimney Elevator Machine Room~~**

Industrial fluorescent luminaries with 2X28W fluorescent lamps with reflector shall be provided for Elevator machine room. The lux level shall be 100 lux. Four (4) numbers of bulk head luminaries with 100 W GLS lamp and wire guard shall be provided in the elevator pit.

5.05.00 **Other Areas**

Distribution & Lighting Boards area

Industrial well glass luminaries with 150 W HPSV lamp and integral control gear shall be provided in the Distribution & Lighting boards area. The lux level shall be 150 lux.

6.00.00 CABLES AND CONDUITS

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

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

AL - 16 sq.mm

CU - 2.5 sq.mm

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

Power, control and trailing cables shall be FRLS type.

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

- From Lighting panels to junction boxes : IC, 6 SQ.mm
- From junction boxes to lighting fixtures (Number of wires per lead as required) : IC, 2.5 SQ.mm
- From Lighting panels to receptacles (15A) (A1) : IC, 6 SQ.mm

6.02.00 Required number of GI pipe conduit of size not less than 32 mm dia shall be provided. Each conduit riser shall run from the lowest embedded pull box to the highest junction box. The lowest pull box shall be located 450mm above grade in the chimney / Cooling Tower. Pull boxes shall be installed at every 10m intervals vertically. The conduit risers shall run adjacent to the stairs such that the pull boxes become easily accessible from the stairs.

6.03.00 Each conduit riser shall have one circumferential conduit at each platform level. The circumferential conduit at each level shall be provided with three (3) more junction boxes equally spaced at the locations of the aviation warning lights. Suitable conduits shall also be provided from the junction box to the respective light point. The GI pull boxes and junction boxes shall be of size atleast 150mm x 150mm x 100mm, 3mm thk, preferably embedded in the concrete shell.

6.04.00 The conduits shall be electrically connected to all circumferential reinforcing rods which are in turn connected to the down conductors.

6.05.00 Conduit joints and connections shall be made thoroughly watertight and rust proof by application of white lead for embedded portion or red lead for exposed portion.

6.06.00 Conduits shall be hot dip galvanised conforming to relevant IS.

6.07.00 Conduit system shall be electrically bonded to the grounding system.

7.00.00 GROUNDING

7.01.00 The Contractor shall provide a complete grounding system including underground matas needed for the RCC ~~chimney &~~ Cooling Tower.

7.02.00 The grounding installation work shall conform to the requirements of the Indian Electricity Rules and Code of Practice for Earthing (IS: 3043) as amended up-to-date and grounding notes & details. DWG No. K9213- DWG-E-0600 attached with the specification. Each piece of electrical equipment/ structure shall be bonded to the grounding system at two (2) points min.

7.03.00 The main ground mat shall be of bare MS round bar of atleast 40 mm dia. buried in earth at a min. depth of 1000 mm below finished grade level. Earth electrode of size 40 MM dia x 3 M length driven into the ground and connected to the ground grid conductor shall be provided, as required, to bring down the ground resistance.

7.04.00 Riser from the ground grid shall be at least 40 mm dia MS round bar and shall project 300 mm above grade / concrete floor level. All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Above grade 75mmx10 mm galvanised mild steel (450 g/m^2 zinc coating min) flats shall be run as main ground conductors securely fixed at intervals not exceeding 1500 mm.

One end of the galvanized mild steel flat shall be connected to the MS round bar riser by electric arc welding and the other end to the equipment by welding / bolting, as necessary. All welded portion shall be painted with bituminous paints against possible corrosion.

7.05.00 The ~~chimney /~~ Cooling Tower ground mat shall be connected to the nearest main plant ground mat by 40 mm dia MS round bar at least two distinct locations.

7.06.00 Ground grid resistance of the grounding system shall not be more than 0.5 ohm.

7.07.00 The ground conductor sizes for grounding of electrical equipment, lighting fixtures, junction boxes etc. shall be as follows :

i)	Distribution Boards, Lighting Panels and motors above 90 KW	:	50 mm x 6 mm GI Flat
ii)	Motors above 30 KW upto 90 KW	:	35 mm x 6 mm GI Flat
iii)	Motors above 5 KW upto 30 KW	:	25 mm x 3 mm GI Flat

iv)	Motors upto 5 KW	:	8 SWG GI wire
v)	Lighting Fixtures, junction boxes, conduits, etc.	:	16 SWG G.I. wire

8.00.00 **~~CHIMNEY LIGHTNING PROTECTION~~**

Lightning protection system shall confirm to the requirements of IS: 2309 amended up-to-date And Lightning protection notes and details. DWG. No. K9213-DWG-E-1000 attached with the specification.

8.01.00 **Air Termination Rod**

The vertical air terminal rods shall be installed at the top of chimney to protect from lightning strokes.

Installation of air terminal at top the chimney for lightning protection shall be 20mm dia lead coated solid copper rod. The projected length of the rod shall be as required to protect the object from lightning stroke.

All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

The air terminal rod shall be properly fixed on the top of the chimney to withstand very high wind pressure.

8.02.00 **Circumferential Band**

The circumferential band shall be 75 x 10 mm galvanised steel flat fixed to the circumference of top of chimney at interval not more than 1.0 m. This shall be mounted with suitable anchors at such a height as to be accessible from the top of platform for maintenance. The anchors shall be embedded in concrete wall of the stack.

8.03.00 **Down Conductors**

Minimum four number of 75mm x 10mm GS flat down conductors shall be provided. These shall be not more than 15m apart on the periphery of the stack at the ground level. The down conductor shall be connected to circumferential band at the top portion of the stack and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode. These conductors shall be continuous as far as practicable. Intermediate breaks shall be electrically bonded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable.

The down conductor shall be clamped along the surface at intervals of 1500mm by GS clamps. The connection between GS flat & GS clamps shall be done by arc welding.

At each chimney platform level, a circular band shall be provided which will be made of 75 x 10 mm GS flat and electrically connected to each down conductor.

8.04.00 **Testing Points**

Test joint shall be provided for each down conductor before termination on earth electrode at a height 1.5m from graded level. Test point shall be covered in 150 x 150 x 150 mm GS box. No sharp bends shall be formed in the down conductors and shall be kept as straight as possible.

8.05.00 **Clamps, Anchors Etc.**

All connections, clamps, anchors etc. of the lightning protection system shall be made of GS fittings. All joints or any other form of electrical connections, unless otherwise specified, shall be clamped or bolted by high pressure contact to form a connection of adequate current carrying capacity and mechanical strength. Soldered connections will not be permitted.

8.06.00 **Vertical and Horizontal Reinforcing Bars**

All reinforcing bars shall be properly bonded and connected to earthing system which shall be separate than lightning protection.

The testing point of the down conductors shall be convenient for testing. Testing point shall be phosphor-bronze gunmetal or copper or other suitable.

8.07.00 **Temporary Lightning Protection**

During construction of chimney, temporary lightning protection shall be maintained by connecting the reinforcement bars to two earth electrodes by means of two 75x10mm GS conductors. These temporary protections shall be provided even after the completion of the chimney till such time the permanent protections are installed.

To avoid maleffect of highly corrosive atmosphere around the chimney due to flue gas and weather, the exposed conductors, connections, clamps, base plate etc. shall be protected by hot dip galvanizing. All site-welded joints conductors shall be coated with anti corrosive paints over a coat of primer.

9.00.00 **COOLING TOWER LIGHTNING PROTECTION**

Lightning protection system shall confirm to the requirements of IS: 2309 amended up-to-date And Lightning protection notes and details. DWG. No. K9213-DWG-E-1000 attached with the specification.

9.01.00 **Air Terminations**

The vertical air terminal rods shall be installed at the top of cooling towers to protect these objects from lightning strokes.

The vertical air terminal except for chimney shall be made of 20 mm dia galvanised steel rod. The projected length of the rod shall be as required to protect the object from lightning stroke.

The air terminal rod shall be properly fixed on the top of the structure to withstand very high wind pressure.

All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

9.02.00 **Down Conductors**

The down conductors shall be 75 x 10 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.

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.

The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located at approximately 1500 mm above ground level.

The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. The down conductor shall be clamped along the surface at intervals of 1500mm by GS clamps.

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.

9.03.00 **Testing Points**

Test joint shall be provided for each down conductor before termination on earth electrode at a height 1.5m from graded level. Test point shall be covered in 150 x 150 x 150 mm GS box. No sharp bends shall be formed in the down conductors and shall be kept as straight as possible.

9.04.00 **Clamps, Anchors Etc.**

All connections, clamps, anchors etc. of the lightning protection system shall be made of GS fittings. All joints or any other form of electrical connections, unless otherwise specified, shall be clamped or bolted by high pressure contact to form a connection of adequate current carrying capacity and mechanical strength. Soldered connections will not be permitted.

9.05.00 **Temporary Lightning Protection**

During construction of cooling tower, temporary lightning protection shall be maintained by connecting the reinforcement bars to two earth electrodes by means of two 75x10mm GS conductors. These temporary protections shall be provided even after the completion of the chimney till such time the permanent protections are installed.

10.00.00 **TESTS**

10.01.00 **Type Tests**

The type tests for fire proof / penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ panel base are as under:

i) Fire rating test.

ii) Hose Stream test

iii) Accelerated aging test.

iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test.

v) Temp. rise test for cable in the fire stop.

vi) Water absorption test followed by fire rating test.

vii) Flame Resistance test for fire retardant coating material.

viii) Anti-rodent test.

Illumination in different areas are as per designed lux level should be established.

10.02.00 **Test Certificates**

Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

The fire proof sealing system shall be installed only after receipt of approval of the test reports.

11.00.00 **DRAWINGS, DATA AND MANUALS**

11.01.00 **To be submitted with the Bid**

11.01.01 Typical general arrangement drawing of ~~Chimney /~~ Cooling Tower showing location of lighting fixtures, lightning protection system, grounding system etc.

11.01.02 Typical general arrangement drawing of A.C. distribution board, lightning board.

11.01.03 Catalogue cuts of various types of lightning fixtures, major components, cables, conduits etc

11.01.04 Type Test Certificate of various equipment

11.02.00 **To be submitted for Approval (A)/Reference (R) and subsequent Distribution**

11.02.01 Dimensional general arrangement drawing of ~~chimney /~~ Cooling Tower showing disposition of aviation warning lights, interior lights on platforms and stairs, receptacles, A.C. distribution boards, lighting boards including their fixing arrangements (A).

11.02.02 Arrangement drawings for lightning protection and grounding system (A)

11.02.03 Single line drawing of A.C. distribution boards and lighting boards (A)

11.02.04 Cable and Conduit layout (R)

11.02.05 Technical data sheet of all equipment / components (A).

11.02.06 Instruction Manuals and Catalogue cuts of all equipment (R)

The manuals shall clearly indicate the method of installation, check-up and tests to be carried out before commissioning of the equipment.

11.02.07 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.

11.03.00 The Contractor may note that the drawings, data and manuals listed are minimum requirement only. The Contractor shall ensure that all other necessary information required to fully describe the equipment / system offered are submitted with his Bid.

VOLUME : IIF/2

SECTION-IV

TECHNICAL SPECIFICATION
FOR
CABLES

CONTENT

ATTACHMENTS

SECTION-IV

TECHNICAL SPECIFICATION FOR CABLES

1.00.00 SCOPE OF SUPPLY

1.01.00 Power and Control Cables shall cover the requirement of entire Plant including the switchyard. The cables shall be furnished in accordance with this specification and annexure.

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 plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

1.02.00 Cable shall be furnished in accordance with this specification and the following annexures :

a)	11 kV, 6.6kV & 3.3 kV Power cables	:	Annexure - A
b)	1100V Power Cables	:	Annexure – B
c)	Control Cables	:	Annexure – C
d)	Fire Survival Cables	:	Annexure – D & E
e)	Flexible Trailing cable	:	Annexure – F

1.03.00 All relevant drawings, data and instruction manuals

2.00.00 CODES & STANDARDS

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

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

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

3.00.00 **DESIGN CRITERIA**

3.01.00 Cables will be generally laid on ladder type trays, perforated type cable trays or drawn through rigid steel conduits [Rigid steel conduits shall be used for interconnection of cables from near-by cable tray to equipment where cable tray cannot be installed as well as to prevent mechanical damage of cables for critical equipment. Moreover in dust prone area the lay out of cable tray shall be in vertical plane].

3.02.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification which one is more stringent.

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

3.04.00 Armouring shall be single round wire of galvanized steel for multicore cables and aluminum for single core cable for power and control cables. For fire survival control cable, the armouring over inner sheath shall consist of single layer of wire / round galvanised steel wire as per IS 3975 amended upto date. For Fire survival power cable, Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire, for multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanised steel wire.

3.05.00 The outer sheath shall have flame retardant low smoke halogen evolution (FRLS) characteristics or fire survival characteristics as applicable and shall meet the requirements of additional tests specified for the purpose.

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

3.07.00 HT cables shall be manufactured by triple extrusion dry cured (CCV) process using pressurized nitrogen.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **General Description**

All Cables shall be furnished in strict compliance with ratings and requirements and sizes as given in Annexures to this Specification.

4.02.00 **Drum Length and Tolerance**

The cables shall be supplied in non-returnable packing steel drum for 11 kV, 6.6 kV & 3.3 kV power cables, wooden drums for 1100V power and control cables, each containing minimum 500 meters length of larger sizes of cable unless specifically asked for. For smaller sizes of cables, each drum shall contain 1000 meters length of cable. Allowable tolerance on individual drum length is $\pm$5%.

4.03.00 **Non-Standard Length**

Non-standard lengths upto 5% of the total ordered quantity may be accepted. However the Contractor will be required to obtain approval before packing the Cables on drums. Non-standard lengths shall not be less than 100 metres in any case.

4.04.00 **Cable identification**

Cable identification shall be provided by embossing on every meter on the outer sheath the following :

a) GSECL

b) Manufacturer's name or trade mark

c) Voltage grade

d) Year of manufacture

e) Type of insulation, e.g. XLPE/PVC/HR85/IE2 etc.

f) No. of core and size of cables.

g) Type of improved fire performance, e.g. FR/FRLS/FS

h) IS number

4.05.00 **Packing**

4.05.01 Cables shall be supplied in non returnable drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden cable drum shall be treated by immersing in copper-nitrate solution.

4.05.02 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment.

4.05.03 The cable drums should carry the following details in printed form:

a) MSPGCL

b) Manufacturer's name or trade make

c) Type of cable & voltage grade

d) Year of manufacture

e) Type of insulation e.g. XLPE/HRPVC/IE2

f) No. of core and size of cables

g) Cable code e.g. FRLS/FS

h) Length of cable on drum

i) No. of length on drum, if more than one

j) Direction of rotation, by arrow

k) Approx. gross mass.

l) IS/IEC number and ISI mark

4.06.00 **Joints and Terminations**

Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements. Straight through joints and terminations for HT cables shall be heat shrinkable type.

4.07.00 **Selection Criteria**

4.07.01 a) HT and LT power cables shall be selected on the basis of current carrying capacity, short circuit rating and permissible voltage drop.

b) While sizing power cables, following aspects shall be reckoned:

i) Ground/Ambient Air temperature

ii) Depth of Laying.

iii) Power Cables touching each other.

c) Cables, for circuit breaker controlled feeders, shall withstand the short circuit current for the fault clearing time. 0.2 Sec.

d) HT cables shall be sized based on the following considerations:

Rated current of the equipment and ground/ambient temperature.

Touching/spacing of cable.

Depth of laying.

The voltage drop of the cable , during motor starting condition , shall be limited to 15% and during full load running condition shall be limited to 3 % rated voltage. Other outgoing feeder /transformer feeder shall be limited to 3% rated voltage.

Short circuits withstand capability

e) For fuse/MCCB/Breaker protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15% during starting for motor feeders. In addition, transformer regulation shall also be considered

for loads fed from 415V PMCC. Incase of other out going line feeder voltage drop shall be limited to 3%.

f) For loads fed from local panels, the total running voltage drop in cable from 415V PMCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%.

g) As per national electric code (NEC) current rating capacity of motor feeder/cables should be 125% of full load current.

h) For welding receptacle, 3% running drop shall only be considered.

The minimum sizes of L.T cable to be chosen are as below:

AL - 16 mm^2 (3 core) & 16mm^2 (2 core); Cu - 2.5 mm^2

4.07.02 Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.

4.07.03 The standard cable sizes, amp capacities, derating factors. as given in IS/IEC will be generally followed.

4.07.04 a) For breaker protected circuits minimum size of the cable shall be as follows:

1100V Power Cable	:	240 Sq mm XLPE AL
6600V & 3300V Power Cable	:	185 Sq mm XLPE AL
11000V Power Cable	:	240 Sq mm XLPE AL

b) For motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly following a second hot start.

4.07.05 For fuse/MCCB protected circuit, the conductor size will depend on full load current subject to voltage drop not exceeding 3%. For practical purposes, the minimum size chosen is as below :

a)	Aluminium	:	16 Sq mm.
b)	Copper	:	2.5 Sq mm.

4.07.06 All control cables shall be 2.5 Sq mm stranded copper cable.

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

Conductors required	Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C

7 or 8	1-9/C
9 or 10	1-12/C
Above 10	Two or more of above cables

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

a) Power.

b) Control, interlock and indication.

c) Metering and measuring.

d) Alarm and annunciation.

e) C.T. Cables.

f) V.T. Cables.

4.08.00 **Cable Identification**

Cable identification shall be provided by embossing on the outer sheath the following :

a) Manufacturer's name or trade mark

b) Manufacturer's name or trade mark

c) Voltage grade

d) Year of manufacture

e) Type of insulation, e.g. XLPE, HRPVC & IE2 etc.

f) No. of core & size of cables

g) Type of outer sheath e.g. FRLS, FS etc.

4.09.00 Selected sizes of power and control cables are given in Annexure-G.

4.10.00 Fire Survival Cables shall be used for important auxiliaries / area as recommended by Standard Technical Specification by CEA as below for the following :

Fire Survival Power & Control Cables shall be used for important auxiliaries/ areas like:

i. DC emergency lube oil pump

ii. DC hydrogen seal pump

iii. Turbine lube oil pump/barring gear

iv. DC emergency lighting for main building and service building

v. DC cables for battery to charger & DC distribution boards

vi. Jacking oil pump

vii. Emergency turbine trip in control room

viii. Boiler Turbine : Generator inter trip which include the interconnection between

- Boiler master fuel trip and turbine trip relays
- Generator trip relays & turbine trip relays
- Generator trip relays & generator breaker
- Generator trip relays & field breaker
- Generator trip relays & unit auxiliary transformer breaker
- Incomer cables for DG board, emergency board, DC lighting board etc.

5.00.00 **TESTS**

5.01.00 **Shop Tests**

The Cables shall be subject to shop tests in accordance relevant IS/IEC standards to prove the design and general qualities of the Cables as below:

5.01.01 Routine tests on each drum of cables.

5.01.02 Acceptance Tests on 1 drum out of every 10 drums chosen at random for acceptance of the lot for every size.

5.01.03 Type test on each type and size of cable, inclusive of measurement of armour DC resistance of power cables on one drum out of every 10 drums of cable.

5.02.00 **Additional Tests**

Following additional acceptance tests shall also be performed on each type of cables having outer sheath with improved fire performance (Type FRLS, FS):

5.02.01 Oxygen index test

The Oxygen index shall not be less than 29.

5.02.02 Temperature Index Test

The measured value of temperature index shall be 21 at a temperature of 250°C for FRLS cables and 350°C for FS cables

5.02.03 Flame Retardance test on single cable and on bunched cables

After the test, there should be no visible damages on the test specimen within 300mm from its upper end.

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly. 3 Hours fire rating test shall be carried out for FS cable as per IEC331

5.02.04 Halogen acid gas evolution test

The level of HCL evolved shall not exceed 20 per cent by weight. HCL evolved shall not be exceed 2% for FS cable.

5.02.05 Smoke density test

The test shall be smoke generation by the outer sheath under fire as per ASTM D 2843. The FRLS cables shall meet the requirements of light transmission of minimum 40% after the test. Minimum transmission shall be 80% for Fire Survival cables.

5.02.06 Test for specific optical density of smoke

The cables shall meet the requirements of IS/IEC.

5.02.07 Test for rodent & termite repulsion property

The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound.

Flammability test shall be carried on finished cables as per following standards-

a) Swedish Chimney test – SS: 424-14-75

b) IEEE std.383 – 1974 latest

c) IEC std. 332-1 and IEC 331

5.03.00 **Test Witness**

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

5.04.00 **Test Certificates**

5.04.01 Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner/Purchaser.

5.04.02 Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review.

5.04.03 The cables shall be dispatched from works only after receipt of Owner/ Purchaser's written approval of the test reports.

6.00.00 DRAWINGS, DATA & MANUALS

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval/ reference and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or elsewhere in this specification.

6.02.00 **To be submitted with the Bid**

a) Manufacturer's catalogues giving cable construction details and characteristics.

b) Cable current ratings for different types of installation, inclusive of derating factors for ambient temperature, grouping etc.

c) Write-up on Manufacturer’s recommended method of splicing, jointing, termination etc. of the cables.

d) Type test reports on 11 KV, 6.6KV, 3.3 KV Power, LT FRLS Power & control, FS power and control cables

e) Filled-up proposal particulars.

6.03.00 **To be submitted after award of contract**

6.03.01 Guaranteed Technical Particulars

6.03.02 Quality assurance plan

6.03.03 Shop Test reports

6.03.04 **Instruction manuals**

The manual shall clearly indicate method of laying, termination, check-ups and tests to be carried out before commissioning.

6.04.00 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, information, etc required to fully describe the cable are to be submitted with the bid.

ANNEXURE-A

RATINGS AND REQUIREMENTS
HV POWER CABLES (11 KV, 6.6KV & 3.3 KV)

1.0 11000/11000V, 6600/6600V & 3300/3300V grade 90^0C continuous rating under normal condition and 250^0C rating under short circuit condition heavy duty XLPE power cable suitable for use in 11000V/6600V/3300V non-effectively earthed system conforming to following requirement and in line with IS-7098, IS-8130, IS-5831 & IS-3975, manufactured by Triple Extrusion Dry Cure (CCV) process using pressurized Nitrogen.

1.1	Conductor	:	Stranded and compacted aluminium conductor of grade H2 & class 2 for all sizes, generally conforming to IS: 8130.
1.2	Conductor Screen	:	Extruded semi-conducting compound.
1.3	Insulation	:	Extruded cross linked polyethylene (XLPE) conforming to IS: 7098 (Part-2)
1.4	Insulation Screen	:	Extruded semi-conducting compound with a layer of non-magnetic metallic tape. For single core armoured cables, the armouring shall constitute the metallic part of screening. The semi-conducting tape shall be easily strippable.
1.5	Core Identification	:	By coloured strips applied on (For three core cables) cores or by numerals.
1.6	Inner Sheath	:	Extruded HRPVC/FRLS compound conforming to type ST2 of IS: 5831 for three core cables. Single core cables shall have inner sheath. Filler material shall also be of type ST2 PVC.
1.7	Armour	:	Galvanised single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables
1.8	Overall Sheath	:	Extruded FRLS HRPVC compound conforming to type ST2 of IS: 5831.
1.9	Drum	:	Steel Drum

ANNEXURE-B

RATINGS AND REQUIREMENTS
LV POWER CABLES [1.1KV (XLPE TYPE)]

1.0 1100 V grade, 90ºC continuous rating under normal condition and 250°C under short circuit condition rating, XLPE heavy duty, power cable conforming to following requirement and in line with IS 7098 Part-I. IS 8130 & IS 5831 and IS 3975.

1.1	Conductor	:	Stranded and compacted plain aluminium of grade H2 and class 2 stranded, high conductivity annealed plain copper for cable sizes upto 2.5 mm^2 conforming to IS:8130.
1.2	Insulation	:	Extruded cross-linked polyethylene (XLPE) conforming to IS: 7098 (Part-1)
1.3	Core Identification	:	By color coding
1.4	Inner Sheath	:	Extruded HRPVC FRLS compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2
1.5	Armour	:	Galvanized single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables
1.6	Overall Sheath	:	Extruded FRLS HRPVC compound conforming to type ST2 of IS: 5831.
1.7	Drum	:	Conforming to IS-10418 (Wooden drum)

ANNEXURE-C

RATINGS AND REQUIREMENTS
CONTROL CABLES

1.0 1100 V grade 85ºC continuous rating under normal condition and 160°C under short circuit condition rating HRPVC Control cable (YWY) conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.

1.1	Conductor	:	Stranded, non-compacted & circular, high conductivity annealed plain copper, generally conforming to IS: 8130.
1.2	Insulation	:	Extruded HRPVC type-C compound conforming to IS: 5831. The minimum volume resistivity of insulation shall be 3.5×10^{14} ohm-cm at $27^{O}C$ and 3.5×10^{11} OHM-CM at $85^{O}C$.
1.3	Core Identification	:	By color coding and numbering at interval of 100mm or less
1.4	Inner sheath	:	Extruded HRPVC compound conforming to type ST2 FRLS of IS: 5831 for multicore cables. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2.
1.5	Armour	:	Galvanised single round steel wire for twin and multicore cables.
1.6	Overall sheath	:	Extruded FRLS HRPVC compound conforming to type ST2 of IS: 5831.
1.7	Drum	:	conforming to IS: 10418 (Wooden drum)

ANNEXURE-D

RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES)

1.1	Conductor	:	Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper wires conforming to Class-II of IS 8130. A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.
1.2	Insulation	:	The insulation shall consist of heat resisting electrometric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS: 6380/1984 amended up to date.
1.3	Laying up of cores (For multicore cables only)	:	The core shall be suitably identified in accordance with IS: 9968 (Part-I). The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fibre binder tape shall be applied over the laid up cores.
1.4	Inner Sheath	:	An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS – 6380/1984,ammended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fibre tape over the insulation.
1.5	Armour	:	For Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire. For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanised steel wire.

1.6	Outer Sheath	:	The extruded outer sheath shall be of special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision. Minimum value of 'Tensile Strength' and 'Percentage elongation rat rupture' shall be 8 Newton/sq.mm. and 250% respectively. The colour of outer sheath shall be black or any other colour agreed mutually between Owner & Contractor.

ANNEXURE-E

RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS CONTROL CABLES)

1.1	Conductor	:	It shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS:8130 / 1984 amended upto date. A suitable heat barrier tape, preferably glass mica tape shall be provided over conductor.
1.2	Insulation	:	The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethelene Propylene rubber) and shall conform to type IE-2 of IS: 6380/1984 latest revision.
1.3	Laying up of cores (For multicore cables only) :		The core shall be suitably identified in accordance with IS: 9968 (Part-I) The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fiber binder tape shall be applied over the laid up cores.
1.4	Inner Sheath	:	An inner sheath of extruded very low halogen (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE3 of IS 6380 / 1984 amended upto date shall be provided over the laid up cores.
1.5	Armour	:	The armouring over inner sheath shall consist of single layer of wire / round galvanised steel wire as per IS 3975 amended upto date.
1.6	Outer Sheath	:	The outer sheath shall be of special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS:6380 latest revision. The colour of outer sheath shall be black or any other natural colour with prior approval of the Owner.

ANNEXURE-F

RATINGS AND REQUIREMENTS
FLEXIBLE TRAILING CABLES

i) 6600 V Unearthed Grade

Flexible trailing cable, annealed plain copper conductor, Class-5 of IS-8130, insulated with EPR, conductor and insulation shielded with EPR, cores screened with ATC wire braiding, cores laid up, HD CSP inner sheathed, proof cotton taped and FRLS HD CSP sheathed overall, conforming to IS:9968. Alternatively PCP sheathing may be acceptable.

ii) 1100 V Grade

1100 V Grade trailing cable shall be plain copper of Class-5 of IS-8130, heat resistant elastomeric compound based on EPR insulation, inner sheath of heat resistant elastomeric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty elastomeric compound FRLS CSP outer sheath.

ANNEXURE-G

CABLE SIZES

Sl. No.	Cable Size	Conductor	Insulation
1.0	**H. T. CABLES (11kV)**		
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 400 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	1 core 70 Sq.mm	AL	XLPE (FRLS)
1.0	**H. T. CABLES (6.6kV & 3.3kV)**		
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 300 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	3 core 185 Sq.mm	AL	XLPE (FRLS)
1.5	1 core 70 Sq.mm	AL	XLPE (FRLS)
2.0	**L. T. POWER CABLES**		
2.1	3 core 2.5 Sq.mm	CU	XLPE (FRLS)
2.2	3 or 4 core 4.0 Sq. mm	CU	XLPE (FRLS)
2.3	3 or 4 core 10 Sq.mm	CU	XLPE (FRLS)
2.4	2 core 16 Sq.mm	AL	XLPE (FRLS)
2.5	3 core 16 Sq.mm	AL	XLPE (FRLS)
2.6	4 core 16 Sq.mm	AL	XLPE (FRLS)
2.7	2 core 35 Sq.mm	AL	XLPE (FRLS)
2.8	3 core 35 Sq.mm	AL	XLPE (FRLS)
2.9	4 core 35 Sq.mm	AL	XLPE (FRLS)
2.10	3 core 70 Sq.mm	AL	XLPE (FRLS)

Sl. No.	Cable Size	Conductor	Insulation
2.11	3.1/2 core 70 Sq.mm	AL	XLPE (FRLS)
2.12	3 core 95 Sq.mm	AL	XLPE (FRLS)
2.13	3.1/2 core 95 Sq.mm	AL	XLPE (FRLS)
2.14	3 core 185 Sq.mm	AL	XLPE (FRLS)
2.15	3.1/2 core 185 Sq.mm	AL	XLPE (FRLS)
2.16	3 core 240 Sq.mm	AL	XLPE (FRLS)
2.17	3.1/2 core 240 Sq.mm	AL	XLPE (FRLS)
2.18	3 core 300 Sq.mm	AL	XLPE (FRLS)
2.19	3.1/2 core 300 Sq.mm	AL	XLPE (FRLS)
2.20	1 core 630 Sq.mm	AL	XLPE (FRLS)
3.0	**CONTROL CABLE**		
3.1	2 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.2	3 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.3	5 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.4	7 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.5	9 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.6	12 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.7	20 core 2.5 Sq.mm	CU	HRPVC (FRLS)
4.0	**FS POWER CABLES**		
4.1	3 core 2.5 Sq.mm	CU	EPR
4.2	2 core 16 Sq.mm	CU	EPR
4.3	3 core 16 Sq.mm	CU	EPR
4.4	4 core 16 Sq.mm	CU	EPR
4.5	2 core 35 Sq.mm	CU	EPR

Sl. No.	Cable Size	Conductor	Insulation
4.6	3 core 35 Sq.mm	CU	EPR
4.7	4 core 35 Sq.mm	CU	EPR
4.8	3 core 95 Sq.mm	CU	EPR
4.9	3.1/2 core 95 Sq.mm	CU	EPR
5.0	**FS CONTROL CABLE**		
5.1	2 core 2.5 Sq.mm	CU	EPR
5.2	3 core 2.5 Sq.mm	CU	EPR
5.3	5 core 2.5 Sq.mm	CU	EPR
5.4	7 core 2.5 Sq.mm	CU	EPR
5.5	9 core 2.5 Sq.mm	CU	EPR
5.6	12 core 2.5 Sq.mm	CU	EPR

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SECTION-IX

TECHNICAL SPECIFICATION
FOR
ERECTION - CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

CONTENT

ATTACHMENTS

SECTION-IX

TECHNICAL SPECIFICATION FOR ERECTION - CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 The scope of work covers complete and efficient design, supply, erection, testing and commissioning of Plant lightning protection system, all cabling and electrical grounding works. The scope shall broadly cover, but not be limited to :

1. Main Power House Building
2. Boiler area, ESP stack
3. Transformer yard
4. All auxiliary buildings (including electrical rooms of respective buildings) and structures as details in the Lead Specification.
5. Overhead interplant cable trestle and pipe cum cable trestle.
6. All electrical equipment as described in Volumes II-F/1 & II-F/2.

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

2.00.00 SCOPE OF SUPPLY

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

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

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

a) Galvanised steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, etc.

b) Galvanised steel rigid/flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanised sheet steel junction boxes, cable fixing clamps, nuts & bolts, etc. as required.

c) Cable termination and jointing kits as necessary.

d) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

e) Mild steel rods, galvanised steel flats, galvanised steel rods, lead coated copper tube suitably brazed with galvanised steel Bend ring galvanised steel wires, etc. required for grounding and lightning protection system shall be supplied in standard lengths.

f) Fire Stop mortal seal, fire retardant cable coating system .

g) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the Purchaser.

2.01.02 a) Main Ground Mat

Laying underground conductors and arc welding the conductors at each crossing and straight run (lap joint). The conductors at the periphery of the mat shall be 1 no. 40 mm diameter M.S. rod and the internal cross conductors of the mat shall be 1 No. 40 mm diameter M.S. rod. Suitable pigtails shall be provided .Diameter of the ground grid conductors as indicated above is minimum . However bidder shall select the actual diameter of conductor with supporting calculation.

b) Grounding Electrode

Fabrication and driving into ground 40 mm. diameter 3000 mm long M.S. rod and connecting them to the grounding mat by arc welding.

c) Column Grounding

i) Concrete Columns

Erection of 1 no. 40 mm. dia. M.S. rod from grounding mat to all concrete columns including necessary fixing, welding of one end of the rod with ground mat and the other end with the column above ground by welding with a short GS flat to edge angles.

ii) Steel Columns

Erection and connection of 1 No. 40 mm diameter M.S. rod from grounding mat to all steel columns including necessary fixing, welding of one end with ground mat and the other end with the column above ground with a short GS flat.

Diameter of the Earth Electrode as indicated above is minimum. However bidder shall select the actual diameter of conductor with supporting calculation

d) Risers

Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Each riser will be 1 No. 40 mm dia. M.S. rod and Minimum 300 mm above grade level/concrete floor level.

Diameter of the Earth Riser as indicated above is minimum. However bidder shall select the actual diameter of conductor with supporting calculation

e) Electronic Equipment Grounding

Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chasis and to be terminated to an insulated ground bus.

Insulated ground bus (400x100x10mm) of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar as shown in the Grounding Notes and details drawing.

All connection made above shall be in the form of a radial distribution system without any parallel ground paths.

Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made of 3M X 3M min 40 mm dia ground rod.

f) All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

2.01.03 a) Air Terminal

Installation of vertical 20mm dia galvanised steel rod (except for chimney). The projected length of the rod shall be as required to protect the object. (on which the rod is fixed from lightning stroke).

Installation of air terminal at top the stack/chimney for lightning protection shall be 20mm dia coated solid copper rod.

b) Horizontal Air Terminal

Erection of horizontal air terminal of 75X 10 mm GS flat conductor in such a way that no part of of the roof will be more than nine meters from the nearest roof conductor.

c) Down conductor

Erection of down conductor 75 X 10 mm GS Flat and 25 X 3 mm GS flat (Conveyor Gallery) conductor. one end of this down conductor connected with air terminal rod/ horizontal conductor at the top of roof/structure and other end connected to the nearest 40mm dia MS

rod riser through test link located at approximately 1500mm above ground level.

d) Electrode (for Lightning protection)

Fabrication and driving into ground 40 mm. diameter 3000 mm long M.S. rod and connecting them to the grounding mat by arc welding.

e) Risers (for Lightning protection)

Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Each riser will be 1 No. 40 mm dia. M.S. rod and Minimum 300 mm above grade level/concrete floor level.

Diameter of the Earth Riser as indicated above is minimum. However bidder shall select the actual diameter of conductor with supporting calculation

f) Shielding Mast

Erection of shielding mast at the top of steel columns cap plates of power house building.

g) All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

2.02.00 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

2.03.00 Necessary drawings, data sheets and Technical leaflets on each piece of material.

2.04.00 **Scope of Services**

The scope includes but is not limited to the followings;

2.04.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work.

2.04.02 The items of erection work shall be performed with respect to the following equipment/materials :

a) Power Cables

b) Cables laid directly buried in ground

c) Control, instrument and special cables

d) Supply and erection of entire cable tray and cable shaft arrangements indoor as well as outdoor area and all associated civil and structural works including foundation and cable trenches for complete plant.

e) Supply and Erection of Grounding system.

f) Supply and Erection of Lightning Protection system.

3.00.00 GENERAL REQUIREMENTS

3.01.00 Codes and Standards

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

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

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

3.02.00 Erection Schedule

3.02.01 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.

3.02.02 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay.

4.00.00 DESIGN CRITERIA

4.01.00 Grounding System

4.01.01 Grounding shall follow the relevant standards/codes amended till date as below:

a) Indian Electricity rules

b) National Electrical Code

c) Code of Practice of Earthing IS 3043

d) Protection of building and allied structures against lightning IS 2309

e) IS- 732, IS 226, IS 2629, IS 2633 & IS 4759

f) IEEE -80 ,IEEE-665

The station grounding system shall be an interconnected network of MS conductor and MS ground rods. The system shall be provided to protect plant personnel and equipment from the hazards, which can occur during power system faults and lightning strikes

4.01.02 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.

Design Basis

The station grounding system shall be designed in compliance with the IEEE-80/ IEEE- 665 considering fault current of 50kA for 1 sec. and shall be subject to approval of owner.

Actual soil resistivity measurement shall be carried out at proposed site for new units during dry season.

The surface Resistivity shall be considered as 3000-ohm meter for Gravel and 1000 ohm-meter for concrete.

a) Major items of equipment, such as generator, switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the under ground grid.

b) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation transformers shall be furnished. All indoor and outdoor electrical equipment and associated non current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system.

c) Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.

d) For Signal/case/intrinsically safe signal, grounding of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit.

e) A grounding conductor (steel wire armor) shall be routed parallel to all power conductors operating above 240 volts.

f) All ground wires installed in conduits shall be uninsulated.

g) Embedded grounding grid of 75x10mm GI flat at basement/grade slab as well as upper floor/suspended slabs shall be provided.

h) In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat

through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two 75x10mm GI flats.

i) Treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two pits shall be provided for each neutral.

j) Dedicated treated earth pit shall be provided for lightning protection system.

k) Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits below the main control room, feed water pump house in turbine house etc.

l) 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.

4.01.03 In order to meet the above objectives, ground grid mesh will be provided for the main plant complex, viz., switchyard, transformer yard adjacent to power house building, power house building and boiler area up to stack, auxiliary buildings, etc.

All electrical equipment, non current carrying metal parts, structures, building steel, lightning protection system, generator/transformer neutrals will be connected to this station ground grid.

The major aspects to be considered for grounding system design are given below :

4.01.04 Ground Grid Conductor

a) Ground grid conductor of mild steel rod shall be used.

b) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm per year over the design life of 30 years. However, the minimum size shall be one (1) no. 40 mm dia mild steel conductor.

4.01.05 Underground Grid

a) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE665.

b) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than 0.5 ohm.

c) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment.

d) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.

e) All ground grid conductor connections will be welded type.

f) Main Plant ground grid shall be connected with the other auxiliary building /area ground grid at least at two (2) points.

g) For test pits, the Electrode will be 100 mm dia. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities

4.01.06 Above Ground Connections

a) Galvanised steel flats shall be used for all connections above earth.

b) Inside building, ground conductors will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.

c) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules.

d) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type.

4.01.07 Equipment Ground Lead

Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

4.01.08 Electronic Equipment Grounding

Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chasis and to be terminated to an insulated ground bus.

Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.

All connection made above shall be in the form of a radial distribution system without any parallel ground paths.

Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made by 3M X 3M MS Rod.

4.01.09 The minimum ground conductor sizes for various equipment and structures are given in Annexure-B.

4.01.10 Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

4.02.00 **Lightning Protection System**

Lighting protection system design shall be as per IS:2309

4.02.01 The main purposes of lightning protection system are to :

a) Provide protection to structures from lightning strokes.

b) Provide a low resistance-conducting path to lightning discharge.

4.02.02 Lightning protection shall be provided for Power House building, auxiliary building , chimney, cooling tower and other structures.

4.02.03 Lightning protection will also be provided for building/ structures where the overall rise factor exceeds 10^{-6} as per IS:2309.

4.02.04 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

4.02.05 System Design

a) Air termination network with down conductors and earthing electrodes will be provided on the basis of IS Code of Practice.

b) Horizontal air termination shall be so laid out that no part of the roof will be more than 9 meters from the nearest conductor.

c) 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.

d) Down conductors will run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.

e) An earth electrode will be provided at the connection point of the down conductor with the station ground.

f) Galvanised steel rods and flats will be generally used for air termination and connections. All connections will be welded type.

g) For air terminals of chimney, lead coated copper tube suitably brazed with G.S. Band ring shall be provided.

4.03.00 **Cabling System**

4.03.01 Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all station auxiliaries.

4.03.02 Cable routing will be done on unit basis as far as possible.

4.03.03 Cables will generally be laid on cable trays, cable trench, cable rack, overhead supported from building steel/structures or cable bridge/cable trestle. Cables shall be run in concrete trenches in transformer yard and in those electrical rooms at ground level, which are without any spreader room below. However cable trench shall be avoided as far as possible in outdoor areas. Cables buried directly in ground are not acceptable.

In indoor pumps, mechanical equipment areas overhead cable trays shall generally be used.

4.03.04 For outdoor area cable shall be laid both in cable trench and cable trays within overhead pipe bridge. However cable trench shall be avoided as far as possible in outdoor areas and cable rack shall be used in Pipe Bridge for outdoor area cable interconnection

4.03.05 For underground crossing of railways, road, etc. additional protection shall be provided in form of hume pipe or concrete encased rigid steel conduits (duct bank).

4.03.06 A.C. and D.C. circuit will not be run in same cable. Further, separately fused circuit will run in separate cables.

4.03.07 Cables for redundant equipment system shall be run in separate trays, as far as possible.

4.03.08 Erection of cabling work shall be executed keeping in view all necessities and requirements of fire fighting codes for Generating Stations having an adverse industrial environment.

4.03.09 Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays such as on Boiler platforms in addition to normal tray cable loadings.

4.04.00 All erection work to be carried out under this specification shall conform to the notes and details given in Annexure-A & drawing attached to this specification.

5.00.00 SPECIFIC REQUIREMENTS - SUPPLY

5.01.00 Equipment and Material

5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

5.01.02 Equipment and materials furnished shall be complete and operative in all details.

5.01.03 All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

5.01.04 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.

5.02.00 Pre-fabricated Cable Trays

5.02.01 Cable trays shall be pre-fabricated ladder type sheet steel with hot dip galvanising furnished in standard length of 2.5 metres.

5.02.02 Cable trays shall be of standard width specified in Annexure-A and drawings.

5.02.03 Cable trays shall be complete with all necessary hot dip galvanised sheet steel accessories such as coupler plates, ground continuity connections, nuts, bolts, washers, hangers, clamps, etc. Also horizontal/ vertical bends, horizontal/ vertical Tee, Reducers, Horizontal cross-pieces, protective covers shall be supplied along with straight runs in order to take care of cable tray alignments in different routes.

5.02.04 All fittings like horizontal/ vertical elbow, horizontal crosspiece, reducer, horizontal tee, etc. should be prefabricated.

5.02.05 Cable trays, fittings & accessories as well as elbows, reducers, tees, crosses, etc. shall be fabricated out of 14 gauge (2 mm thick) hot rolled mild steel sheets.

5.02.06 Contractor shall supply 16 gauge (1.6 mm thick) perforated type hot rolled mild steel sheet covers for vertical cable shafts up to a height of 2.5 metres from floor level. The perforated covers used for the vertical raceways may be of one or more pieces along the width of the raceway, depending on the width of the raceway and shall be bolted to the structural framework of the raceway.

5.02.07 The cable trays, fittings and accessories including all bolts, nuts, screws, washers, etc. shall be hot dip galvanised after fabrication as per IS:2629. Galvanising shall be uniform, clear, smooth and free from acid spots. Should the galvanising of the samples be found defective, the entire batch of steel will have to be regalvanised at Contractor's cost.

The amount of zinc deposited shall not be less than 610 gms per square metre of surface area and in addition the thickness of the zinc deposit at any spot whatsoever, shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elcometer or any other instrument and reject any component, which shows thickness of zinc at any location to be less than 75 microns.

5.02.08 Each 2.5M long section of all types of cable trays & each fittings like elbow, tees, crosses, etc. shall be provided with two nos. hot dip galvanised side coupler plates & associated bolts, nuts and washers on each side.

5.02.09 The Contractor shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and that such tests are adequate to demonstrate that the equipment will comply with the requirement of this specification.

The tolerance on dimensions shall be in accordance with appropriate Indian Standards. The extent of the tests to be performed by the contractor shall include but not be limited to the following:

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 100 Kg per metre will be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7 mm.

5.02.10 For other details refer CABLING NOTES AND DETAILS annexed to this specification.

5.03.00 **Conduits and Accessories**

5.03.01 Conduits shall be of rigid steel, hot-dip galvanised, furnished in standard length of 5 metres, threaded at both ends.

5.03.02 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.03.03 Each piece of conduit shall be straight, free from blister and other defects, internal surface shall be of smooth finish and covered with capped bushings at both ends.

5.03.04 The contractor shall provide and install all rigid steel conduits, mild steel pipes, flexible conduits rigid PVC pipes, etc. complete with accessories such as tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work.

5.03.05 Steel conduits with interior coating of silicon epoxy ester for ease of wire/cable pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanised. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS:9537. In chemical handling areas, Battery Room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.03.06 For sizes above 63 mm mild steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. Pipes shall be manufactured by electric welding process. These pipes shall be of heavy duty class as per IS:1239 and shall have ISI mark. Pipes shall be supplied in lengths of approximately 5 metres. Pipes, fittings & accessories shall be hot dip galvanised both on inside and outside.

5.03.07 Flexible conduits shall comply with IS:3480. They shall be made with bright, cold-rolled, annealed and electro-galvanised mild steel strips. Flexible conduits shall be used between embedded conduits/pipes and the motor terminals. Flexible conduits shall also be used between fixed conduit and any equipment terminal boxes where vibration is anticipated or equipment that require regular removal.

5.03.08 Rigid PVC conduits conforming to IS:4985 shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are straight ones generally the PVC pipes with special Bell Mouthing shall be of 110 mm,160 mm & 200 mm outside diameter and shall be suitable for working pressure of 6 kg/sq. cm. The length of each pipe shall be 5 to 6 metres. Necessary fittings & accessories as may be required for the installation shall also be provided.

5.04.00 **Junction Boxes**

5.04.01 Glass Fibre Reinforced Junction Boxes

1. No. of Ways:12 / 24 / 36 / 48 with 20% spare terminals.

2. Design:

Junction boxes shall be Glass Fibre Reinforced with saturated polyester informing to standards like DIN 16911 type 803 / 16913 type 834, 5 self extinguishing in accordance with ASTM D 635 / UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance between – 10 to 100 deg C. Impact resistance shall be greater than 7 Nm, (EN 50 014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/ mm, halogen free toxicity, the enclosure and door cover shall be painted and electrostatically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

Doors:

With integrated viewing window of 3 mm resistant plexi – glass or equivalent. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

a) Protection Class :

Protection Category shall be IP 66 to EN60 529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane / chloroprene. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred).

b) Mounting clamps and accessories :

Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plants etc. of steel shall be powdered coated. The support rails for terminal box shall be zink coated.

c) General :

i) JBs shall have small canopy at the top.

ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.

iii) Cable entry shall be from bottom side only.

iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.02 Steel Junction Boxes :

a) No. of Ways:12 / 24 / 36 / 48 with 20% spare terminals.

b) Design :

Junction boxes shall be designed in accordance with NEC, articl 370, paragraph 18, 20 or equivalent standards.

c) Enclosure :

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosre and door cover shall be surface finished clean, degreased, fospheted, deep coated primed (preferably in RAL 7044) and electrostatically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door. The sheath steel thickness shall be minimum 2 mm.

d) Doors :

The doors shall be hinged and lockable. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

e) Protection Class :

Protection Category shall be IP 66 to EN60 529 / 10.91 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred).

f) Mounting clamps and accessories:

Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required

5.04.03 The junction boxes shall have the following indelible marking

- Circuit nos. on top by white-stenciled paint at site.
- Circuit nos. with ferrules (inside) as per approved drawing.
- Danger sign in case of 415V circuit.

5.05.00 **Terminals**

5.05.01 Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

5.05.02 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.

5.06.00 **Cable Termination & Jointing Kits**

5.06.01 The Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables, etc. along with all accessories & consumables required for making termination and joints complete. All the materials and components of the termination/joints shall be suitable and compatible with the type of cables for which the terminals/ joints are intended.

5.06.02 The straight through joints of H.T. and L.T. cables shall be of Tapex/ Paracast/Parawrap type. The end termination kits for H.T. cables shall be of Raychem/3M/Elastimold type. Cable joint or end terminations on Electrical equipment shall be suitable for Indoor & Outdoor use, as the case may be.

5.06.03 Glands and lugs required for termination of H.T., L.T. and instrumentation cables shall be supplied by the Contractor in required quantity.

5.07.00 **Cable Glands**

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

5.08.00 **Cable Lugs**

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

i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.

ii) Copper tubular terminal end for solderless crimping to copper conductors.

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

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

5.09.00 **Consumables and Hardware**

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

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

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

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims, etc. 5.09.03 Supply of cement, sand, stone, etc. required for the execution of the contract shall be the responsibility of the Contractor.

5.10.00 **Testing Equipment**

5.10.01 The major testing equipment that are required to be provided by the Contractor are listed below :

a) Insulation Tests

i) Power operated Meggar - 1 KV and 10 KV grade

ii) Hand operated Meggar - 1 KV grade

b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms.

c) High potential testing set - roller mounted type

d) Tong testers of suitable ranges.

e) Contact resistance measuring set for micro-ohms.

f) Torque wrench of various sizes.

g) Multimeters, test lamp, field telephone with buzzer set, different gauges, etc.

5.10.02 The list of equipment is indicative only. Any other test equipments required will be arranged by the Contractor.

6.00.00 **METHODS AND WORKMANSHIP**

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/ electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.

6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 **INSTALLATION**

7.01.01 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.

7.01.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.01.03 Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches tunnels/overhead trays in conduits, etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/ termination kits, lugs, glands, ferrules, tapes, etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

7.01.04 Grounding installation work shall mean erection, jointing/ brazing/ welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.

7.01.05 Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors, etc. of lightning protection system.

7.02.00 **Cable Trays**

7.02.01 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces will be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

7.02.02 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.

7.02.03 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

7.02.04 The cable trays shall be supported in general at a span of exceeding 1.25 metres horizontally and 1.0 metre vertically.

7.02.05 Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access, for installing & maintaining the cables.

7.02.06 Complete cable tray support structure after installation shall be inspected/ tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.

7.02.07 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship, etc.

7.02.08 The Contractor shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.

7.02.09 Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.

7.02.10 Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.

7.02.11 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way.

7.02.12 Cable tray/conduit system will be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.

7.02.13 Cable tray/conduit system will be constructed to prevent drainage of water into equipment or building.

7.02.14 Cable tray/conduit system shall be electrically continuous and grounded.

7.02.15 Different voltage grade cables will be laid in separate trays when trays are run in tier formation. Power cables will normally be on top trays and control/instrumentation cable on bottom trays.

7.03.00 **Cable and Conduits**

7.03.01 The Contractor shall install, terminate and connect up all cable and conduits as per drawings and cable schedules.

7.03.02 The drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Engineer.

7.03.03 Approximate lengths of cable and conduit runs will be shown by the contractor in the cable schedule for guidance only. Before commencement of work the Contractor shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.

7.03.04 The Contractor shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.

7.03.05 Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.

7.03.06 Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the owner's Engineer.

7.03.07 At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.

7.04.00 **Conduit and Accessories**

7.04.01 Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Engineer.

7.04.02 The Contractor shall furnish all conduits complete with accessories as required.

7.04.03 Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Contractor.

7.04.04 Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.

7.04.05 The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.

7.04.06 Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.

7.04.07 Pull boxes will be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.

7.04.08 Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting, etc. Conduits shall be supported at least every 2000 mm.

7.05.00 **Cables : Storage and Handling**

7.05.01 Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.

7.05.02 Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

7.05.03 In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.

7.05.04 For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending.

7.05.05 The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.

7.05.06 While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums.

7.05.07 Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.

7.05.08 Empty cable drums shall be returned to the owner.

7.06.00 **Cable Laying**

7.06.01 Cable shall generally be installed in ladder type prefabricated trays except for some short run in rigid/flexible conduit for protection or crossings.

7.06.02 Cables laid on trays and risers shall be neatly dressed and clamped with self-locking type fire resistant nylon ties at an interval of 750 mm. for horizontal and vertical runs, in case of both power, control and instrumentation cables.

7.06.03 All single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon ties at an interval of 750 mm.

7.06.04 All H.T. multicore power cables and L.T. multicore power cables with cross-sectional area including & above 95 sq.mm shall be clamped individually by self-locking type fire resistant nylon ties.

7.06.05 L.T. power cables of cross sectional area less than 95 sq. mm. and all control and Instrumentation cables shall be clamped in bunches with self-locking type fire resistant nylon ties. The number of cable in one bunch shall not exceed eight (8).

7.06.06 Prior to laying of cables inside the indoor and outdoor trenches, the contractor shall properly clean the trenches.

7.06.07 In outdoor areas, buried cables shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.

7.06.08 When buried cables cross road/railway track, adequate protection shall be provided in the form of hume/galvanised iron pipes laid at a minimum depth of 1 meter below ground.

7.06.09 After completion of installation and prior to connection, all power cables shall be subjected to a high potential test.

7.07.00 **Cable Tags & Markers**

7.07.01 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 30.0M and exit from any equipment, junction box. When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.

7.07.02 The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.

7.07.03 The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.

7.07.04 The Contractor shall furnish and install all tags and markers stated above.

7.07.05 For buried cable, the marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change of direction.

7.08.00 **Cable Termination and Connection**

7.08.01 The termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.

7.08.02 The work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement.

7.08.03 Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.

7.08.04 Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.

7.08.05 The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.

7.08.06 The Contractor shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.

7.08.07 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.

7.08.08 Control/instrumentation cable cores entering control panel/ switchgear/ MCC, etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

7.08.09 The Contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.

7.08.10 Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number.

7.08.11 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.08.12 All cable entry Points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.09.00 **Termi-point Connection**

a) The conductor (solid or stranded) is forced against the contact area of the 2.4 x 0.8 mm or 1.6 x 0.8 mm connection pin by means of a

tin-coated bronze clip, which maintains a constant pressure. In the Maxitermi-point method, 2.4 x 0.8 mm pins is used without exception.

b) The conductor is "shot" onto the pin together with the clip. The resulting friction causes both the wire and the contact area of the pin to be cleaned and any oxide layers to be penetrated.

c) Apart from this the wire and the clip are deformed in such a way that a gas-tight connection with very good electrical and mechanical properties is established.

d) A special manually or pneumatically driven gun is required. Up to 3 adjacent connections can be "shot" onto one pin. In most cases only one clip at the base of the pin is attached. The sections above usually remain vacant. Any part of a connection pin may be reused several times after removal of the existing clip connection. Contact areas below existing connections that have become vacant can be reused by pushing the connections above the vacant space downwards, so that the new connection can be "shot" on above the top connection. The single jumper wires need not be specially prepared as the end insulation is stripped within the tool.

e) This connection method requires special insulation of the wires. The diameter of solid conductors is 0.8 mm the cross-section of stranded conductors 0.5 Sq.mm.

f) The conductor is deformed greatly when attached and is to be shortened by 3 mm when disconnected and reused.

g) Strips and special tools for termi-point connection shall be supplied by the Contractor.

7.10.00 **Cable Joints**

7.10.01 Cable shall be installed without joints as far as practicable.

7.10.02 If however jointing becomes necessary, it shall be made only by qualified cable jointer and strictly in accordance with manufacturer's recommendation.

7.11.00 **Grounding**

7.11.01 The Contractor shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian standards and enclosed grounding and lightning protection notes and details.

7.11.02 The grounding shall be done by conductors of adequate sizes (size shall be selected by the bidder with supporting calculation) and the same shall be connected to the risers of main ground mat.

7.11.03 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be

connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.

7.11.04 All ground conductor connections shall be made by electric arc welding/ brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. The rods/connection shall be coated with cold galvanizing /weather resistance anti corrosive paints.

7.11.05 All ground conductors shall be painted black for easy identification.

7.11.06 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

7.11.07 Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

7.11.08 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points.

7.11.09 The underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth of minimum 1 metre below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes as shown in the relevant drawing.

The Contractor will plan and organise works to lay the grounding mat in the same sequence in which the building and equipment foundation is being done.

7.11.10 Ground Electrode

Ground electrodes will be 40 mm dia (minimum) and 3 metre long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by are wilding process.

7.11.11 Risers

Risers are required for connecting the equipment and structures with the ground mat. These will be 1 No. 40 mm dia (Minimum) M.S. rod. laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown.

7.11.12 Column Grounding

All columns are required to be grounded by 1 no. 40 mm dia (Minimum) M.S. rod from ground mat. Laying, supporting along with foundation, connecting at

ground mat are within the scope of this specification. At least 300 mm length of the above rods shall be left free above the grade level/concrete floor level for connection with columns.

7.11.13 Electronic Equipment Grounding

Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chasis and to be terminated to an insulated ground bus.

Insulated ground bus of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar.

All connection made above shall be in the form of a radial distribution system without any parallel ground paths.

Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made by 3M X 3M MS Rod.

7.12.00 **Painting**

7.12.01 The Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of battleship grey (shade no. 632 of IS:5) synthetic enamel paint.

7.13.00 **Galvanising**

7.13.01 The galvanising shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanising of the samples be found defective, the entire batch of steel has to be regalvanised, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square metre of surface area and in addition, the thickness of the zinc deposit at any spot whatsoever shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument and reject any component which shows thickness of zinc at any location less than 75 microns.

7.14.00 **Excavation and Back Filling**

7.14.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

7.14.02 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

7.14.03 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

7.14.04 All excavation shall be backfilled to the original level with good consolidation.

7.15.00 **Steel Fabrication**

7.15.01 All racks, trays, supports, hangers & brackets wherever necessary shall be fabricated by the Contractor.

7.15.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge and burns so as not to cause any damage to personnel or cables.

7.16.00 **Cleaning up of Work Site**

7.16.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

7.16.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

8.00.00 **TESTS**

8.01.00 Shop Tests

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on panels/junction boxes shall include :

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

8.02.00 **Site Tests**

8.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.

Cable cores shall be tested for :

a) Physical damage

b) Continuity

c) Correctness of connections as per relevant wiring diagram

d) Insulation resistance to earth

e) Insulation resistance between conductors

f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc.

8.02.04 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.03.00 **Test Certificates**

8.03.01 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 To be submitted with the Bid

9.01.01 Make, type and catalogue number of different electrical items and accessories along with technical leaflets, data sheets etc.

9.01.02 Typical General arrangement drawings showing constructional features, fixing arrangement of pre-fabricated cable trays.

9.01.03 Bill of Materials for cable trays and accessories, conduits & accessories.

9.01.04 Layout of Grounding system & lightning protection system showing connection and other details along with backup design calculations and detailed write up.

9.01.05 Bill of materials for grounding and lightning protection system.

9.01.06 Drawing showing details of equipment grounding.

9.02.00 **To be submitted after Award of Contract**

9.02.01 Make, type & catalogue number of cable termination kits, joints & accessories.

9.02.02 Detail dimensional drawings showing constructional features, grounding, fixing arrangement etc.

9.02.03 Bill of Materials for Pre-fabricated cable tray and accessories, Conduits & accessories.

9.02.04 Dimensional G.A. drawings and data sheets for different equipment and items supplied under this specification.

9.02.05 Layout drawing of Grounding system and Lightning protection system showing connection details along with backup design calculation and detailed write up.

9.02.06 Bill of material for grounding system and lightning protection system.

9.02.07 Drawing showing details of equipment grounding system.

ANNEXURE-A

NOTES AND DETAILS FOR CABLING SYSTEM

1.00.00 GENERAL

1.01.00 These notes and details shall be read and construed in conjunction with Specification and the drawings meant for cable tray details and supporting arrangements in Trench, Racks etc., enclosed elsewhere. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The Cabling System installation work shall conform to the requirements of the latest revisions of the following standards/codes

a) Indian Electricity Rules, 1956, with up to date amendment.

b) I.S. Code of Practice.

2.00.00 CABLE ROUTING/LAYING

2.01.01 Cables shall generally be laid on ladder type cable trays either in trenches or overhead supported from building steel/structures except in some cases cables may have to be laid underground and for short runs in conduits for protection or crossing.

2.01.02 For interplant connections, the cables may be directly buried or routed through an overhead cable bridge or cable trenches/tunnels selection being dependent on site constraints.

2.01.03 For underground crossing of railways, roads etc. hume pipes shall be used and shall be laid at a depth of minimum 1000 mm such that cables shall not be damaged.

2.01.04 In boiler area, trench will be avoided as far as practicable. The cable racks shall be supported from Boiler structure in vertical configuration with suitable cover to avoid deposition of coal dust as far as practicable.

2.01.05 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. Power cables shall be on top trays and Control/Instrumentation cables on bottom trays, and it is recommended that trays for cables of different voltage levels be stacked in descending order with higher voltage level above.

2.01.06 Cables for redundant equipment/system shall be run in separate trays in separate route.

2.01.07 Cables from two different services viz. supply from station board and supply from unit board shall be fully segregated to prevent simultaneous damage due to fire in one of the services.

2.01.08 Low level signal cables and other special Instrumentation and Control cables shall run in separate trays. In general, a minimum of 1500 mm clearance shall be maintained between these cables and noise generating equipment (large motors, generators, transformers etc.).

2.01.09 The cable spreaders of each unit shall be compartmentalized by provision of fire proof partition wall.

2.01.10 The floor of the cable spreader rooms will have to be made water proof so that water does not percolate to lower levels in the event of fire fighting operations. Adequate arrangement for efficient drainage of water shall be provided. The cable raceways should also be suitably curved to avoid water entry through this place.

2.01.11 Cabling System for CHP

a) Cable in CHP area shall be generally routed through the conveyor gallery / tunnel, TP / Buildings by separate supporting structures, Pipe cum cable bridge. The cables shall be laid in vertical trays.

b) In substation & Switchgear room cable shall be laid in horizontal cable trays installed in cable vault room.

c) Cables may also be routed through hume pipes to enter into various buildings from the nearest overhead cable trestle/substation building..

d) Overhead cable trestle/cable bridge shall be provided for routing of cables between the following Sub-Stations/buildings:

i) Main CHP Substation Building and Crusher House.

ii) Main CHP Substation Building and Pump House.

iii) Wagon Tippler Substation Building and TP.

The bottom of the steel supporting structure shall be generally at 2.5m above the grade level except for road crossing and rail crossing where the same shall be 6.5 m and 9.0m respectively above grade level.

e) Cable trays shall be laid out horizontally in sub-station buildings and pump-house whereas the same shall be installed vertically inside transfer points, crusher house, conveyor gallery/tunnel etc. The cable trestle shall have a minimum 600mm clear walk way all along its routes and shall have maintenance platforms as required.

f) Separate trays shall be provided for H.T., L.T., control and instrumentation cables. LT mutlicore Power cables shall be laid touching each other in single layer & touching formation and single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centre lines and clamped at every two meter while control and instrumentation cables shall be laid in maximum of two layers formation. Single core HT power cables shall be laid on trefoil formation with a distance of four times the diameter of cable between trefoil centre lines and clamped at every two meter and Multi core power cables shall be laid in single layer & touching formation. Normally cable trays shall be designed with 70%

fill-in criteria and conduit 40% fill-in criteria. Same cable laying philosophy shall be considered in other areas of the plant, if not specifically mentioned.

2.02.00 **Cable Trays/Supports**

2.02.01 Cable trays and covers shall be pre-fabricated type, constructed from minimum 14 SWG sheet steel for trays and 16 SWG for covers and hot-dip galvanized after fabrication.

2.02.02 Cable tray supports shall be cantilever type for each installation. All supports and hardware shall be hot-dip galvanised.

2.02.03 Standard cable tray width shall be 600 mm. However, trays with 450, and 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose, some perforated type cable trays of width 150 and/or 100mm may be used particularly in Boiler Platform area, and 600, 450, 300 mm perforated trays may be used depending on site requirement.

2.02.04 Cable trays shall be ladder type with 250 mm rung spacing, 100 mm depth and rung width not less than 50 mm.

2.02.05 All weld for cable tray supports shall have a min. throat thickness of 6 mm.

2.02.06 Cable trays in areas subjected to excessive coal dust, or mechanical damage will have hot-dip galvanised sheet metal tray cover installed on front tray in vertical run and inverted `V' type on upper tray in horizontal run.

Where covers are used on trays containing power cables, consideration should be given to ventilation requirements. Areas where corrosive chemicals are likely to be handled, cable tray and covers shall be epoxy painted.

2.03.00 **Conduits**

2.03.01 Conduits shall be rigid steel coated type; minimum size of conduit shall be limited to 19mm.

2.03.02 Steel conduits with interior coating of silicon epoxy ester for ease of wire pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanised. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS:9537 Part-II. In chemical handling areas, Battery room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion.

2.03.03 Conduit runs shall be supported at an interval of 750 mm for vertical run and 1000 mm for horizontal run.

2.03.04 Conduits shall be sized so that conduit fill (ratio of total cable area to conduit area) shall not exceed the following :

One Cable	:	53%
Two Cable	:	31%
Three Cables & Up	:	40%

2.03.05 Conduit runs shall be provided with necessary bends as required.

2.04.00 **Installation**

2.04.01 The Contractor shall install terminate and connect up all cables and conduits with supporting arrangements as per drawings, cable schedules and interconnection chart/drawings.

2.04.02 The HV power cables of 11 KV/6.6/3.3 KV shall be laid in trays or racks as follows :

a) In single layer only.

b) Multi core cables to be laid in touching with each other.

c) Single core cables to be laid in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centerlines and clamp every two meter.

2.04.03 1100V grade power cables shall be laid in single layer in trays.

2.04.04 1100V grade mutlicore power cable shall be laid in touching formation to each other.

2.04.05 1100V grade Single core cables to be laid in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centerlines and clamp every two meter.

Control and Instrumentation cables can be laid up to a maximum of two layers in each tray.

2.04.06 Normally cable trays shall be designed with 70% fill-in criteria and conduit 40% fill-in criteria. Same cable laying philosophy shall be considered in other areas of the plant, if not specifically mentioned.

2.04.07 The trays shall be run with a vertical spacing of 300 mm for overhead cable trays as well as inside cable trenches. A minimum of 225 mm clearance shall be provided between the top of tray and beams, cold piping, 500 mm clearance for hot piping/object to facilitate installation of cables in tray.

2.04.08 Adequate pull boxes shall be provided in conduit run to facilitate cable pulling in long runs and also to ensure that there will be no more than 270 Deg. bends between pull points.

2.04.09 Cable tray/conduit system shall be installed to accommodate cable manufacturer's recommended maximum pulling tension and minimum bending radius.

2.04.10 All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows :

i) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways.

ii) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire.

iii) For all H.T., L.T., Relay and Control panels, Control desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate.

2.04.11 All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.

2.04.12 The portion of galvanised steel, which, if required, undergoes any welding at site shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

2.04.13 Refer Clause No. 3.00.00 below for details of fire-proof sealing and fire protection coating.

2.05.00 **Identification**

2.05.01 The complete cabling system shall be properly identified. Methods for identification of cabling system shall be furnished to the successful EPC Contractor shall strictly adhere to the said methods.

2.05.02 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

2.05.03 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate, projected above ground level.

2.05.04 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, at each bend and at every thirty (30) metres in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, MCC, control & relay panels etc. wherever required for cable identification, such as where a number of cables enter together through a gland plate.

3.00.00 FIRE-PROOF SEALING / FIRE PROTECTION COATING SYSTEM

3.01.00 The Fire proof sealing / fire stop system / fire protection coating system is required to prevent spreading of fire from one placed to other place (or one zone to other zone) through the openings in wall / floor, cables laid in trays / racks and openings below Electrical Switchgear / MCC / Distribution boards / Cabinets / Panels, etc.

3.02.00 **Scope of Work**

3.02.01 The scope of work includes but is not limited to the following supply and services:

i) Fire Stops in wall / floors.

ii) Fire stops below switchgear / MCC / Switchboards, junction boxes / panels / cabinets, etc. which are floor mounted type.

iii) Fire retardant coating to be applied for installed cables.

iv) Minor civil / structural works for installation of the entire work.

v) All necessary erection materials, consumables and sundry items to complete the entire work for satisfactory and trouble free operation.

vi) Any special tools & tackles.

vii) Conducting the type test of fire proof sealing system in presence of Owner's engineers.

viii) All relevant Drawings, Data sheets and instruction manuals.

ix) Fire proof barrier walls.

x) Fire proof doors.

3.03.00 **Design Criteria**

3.03.01 Fire Proof Sealing System

The material / components used for fire-proof sealing system shall be provided to meet the following requirements:

i) Life expectancy should not be less than 30 years from the date of installation.

ii) Free from shrinkage or cracking or asbestos in composition and should achieve smoke and gas tightness during fire and should be modifiable.

iii) Not to generate toxic gas and harms to the personnel handling the system.

iv) Prohibition of production of acid or alkali during gas generation.

v) Will not produce suffocating / corrosive gas.

vi) Repellant to paste / rodent / termite.

vii) Expansion co-efficient - very low which is to be comparable with masonry concrete.

viii) Not soluble / reactive to acid, water, alkali.

ix) Thermal conductivity - low.

x) The material in contact with the cables in the fire-proof sealing system shall be compatible with the material used for outer sheath of cables.

xi) It should not have any adverse effect on the cables and should not alter the current carrying capacity of the cables.

xii) Retrofit in design to accommodate not less than 15% more addition of cables depending upon the size of cables, physically and chemically stable.

xiii) Capable of withstanding vibrations, drop-loads, foot traffics, mechanical loads, etc.

xiv) The F.P.S. system shall maintain its integrity and perform satisfactory even after

a. Remaining in water for a long time.

b. Accelerated thermal aging.

c. Sustaining vibrations.

xv) The design and construction of F.P.S. system shall specifically take into account the fact that under seismic disturbances, normal load, short circuit and fire conditions, the cable / cable trays will be subject to movement, expansion and oscillation and this shall not result in any damage or cause dislocation of the F.P.S. system or the material constituting the FPS System.

xvi) Non-hygroscopic, non-inflammable and shall not get affected over a period of time due to humidity, moisture and ozone etc. and should not contain volatile solvents which may cause a fire hazard during application.

xvii) The fire rating shall not be less than two (2) hours and the system shall be stable after applicable of water jet in the exposed side in order to extinguish fire.

3.03.02 Fire Protection coating to be applied on installed Cables:

The cables shall be coated with fire protection material of 2 mm dry thickness at the strategic locations as follows so as to limit the spread of fire:

i) At fire stops in walls and floors on either side upto 500 mm length.

ii) At fire stop below Electrical Switchgears/ MCCs/ Panels/ Cabins, etc. on one side coating of 500 mm length, i.e., on the cable vault side / cable trench side.

iii) Length of 500 mm on all sides of the junction/crossing of cabling work in open cable routes/ cable trench.

iv) In fire risk areas and where specified at suitable intervals as decided upon side conditions in open cable routes.

v) Where necessary and specified at site intervals along cable routes in cable trenches.

vi) The coating shall be applied evenly on the cables only.

3.03.03 The fire protection coating shall have the following properties/composition:

i) Asbestos free, non-volatile, not eatable by vermin, harmless and non-irritant to skin of human.

ii) Not affecting the current carrying capacity of the cables and the properties of the installed cables.

iii) It shall delay fire damage to cables and prevent flame spreading meeting the requirement of IEEE - 383.

iv) Coating material shall show no signs of cracking and peeling when the coated cable is bent to the radius of minimum 12 times the diameter of the maximum size cable at 180°C.

v) The limiting oxygen index of the material shall not be less than 60% as per ASTMD - 2863.

vi) Life expectancy equivalent to the cable installations.

3.03.04 The various openings in the cable vault, vertical/ horizontal raceways of cables penetrating walls/ floors and the bottom of Electrical switchgears/ MCCs/ distribution boards/ Cabinets/ Panels shall be provided with fire stop systems. Cables passing through the openings at various locations are laid on various tiers of the cable trays/ racks in the bunch formation. Bidder shall visit the site to assess and get acquainted with the type of cable installation where fire stops and fire protection coating are to be provided. In case steel frames are required to be fabricated and fixed in the openings, the fabrication of frame & fixing of the same shall have to be done by the Contractor without any extra cost. The necessary steel section for fabrication of frames shall be supplied by the Contractor without any extra cost. Any civil works required to be done in the openings shall be carried out by the Bidder. Bidder shall also include one set of tools & accessories required for addition or removal of cables after the seal is made.

3.04.00 The bidder shall quote the unit rates for provision of supply, installation, testing & commissioning of the fire proof seals as given in the specification. Bidder is requested to quote the unit rates per square metre (i.e., area) basis of the area of the fire sealing material.

3.05.00 **Type Test On Penetration Seals**

3.05.01 The type tests for fire proof/ penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ MCC/ panel base are as under:

i) Fire rating test.

ii) Hose Stream test.

iii) Accelerated aging test.

iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test.

v) Temp. rise test for cable in the fire stop.

vi) Water absorption test followed by fire rating test.

vii) Flame Resistance test for fire retardant coating material.

viii) Anti-rodent test.

3.05.02 Fire Rating Test

This test shall be carried out to prove the guaranteed power rating duration of the system in respect of stability, integrity and insulation characteristics of the complete system. The penetration seal system as a whole conforming to ASTM 814 and as per BS:476 Part-8 shall be built with the necessary component. The fire test shall be built with the necessary component.

The test specimen of the penetration seal built with 9-10 nos. armoured cables of various sizes passing through the seal shall be fitted to the gas fired furnace and shall form the upper most face of the furnace. The gas fired furnace shall have provision to achieve standard time temperature characteristics for fire tests as mentioned in BS-476 Part-8, according to which the temperature required to be maintained are as under:

Heating time in minutes	Temperature in the furnace
30 minutes	821°C
90 minutes	886°C
120 minutes	1029°C
150 minutes	1062°C
180 minutes	1090°C
210 minutes	1113°C
240 minutes	1133°C

The pressure inside the furnace at the time of test shall be more than 2 mm water gauge. The penetration shall be subjected to fire test with surface exposed to controlled fire in the furnace conforming to time / temperature characteristics as mentioned above. During the test, the temperature of both the faces of the penetration seal i.e. one which is exposed to fire and the other unexposed, shall be measured by calibrated thermocouples after regular interval of 5 minutes. At least 3 thermocouples shall be provided for temperature measurement of each face.

3.05.03 The results at the end of the tests shall be interpreted or failure criteria as under:

i) The system is deemed to have failed to maintain stability if there is a total collapse of the penetration seal.

ii) In case cracks are seen on the face of the penetration seal or cracks through the sealing system through which the flame / or gas can pass,

the system is deemed to have failed to maintain integrity. The development of crack is characterized by ignition cotton wool held near the seal on the unexposed surface at a distance of about 30 mm from the aperture.

iii) In case the mean temperature rise of unexposed surface of seal exceeds 140°C above the initial temperature or temperature of unexposed surface exceeds 180°C, the system shall deemed to have failed in respect of insulation characteristics.

iv) Temperature measurement on the unexposed side of the penetration seal specimen shall be measured by the thermocouple on the surface of penetrating items and on fire stop material in accordance with ATME-814/UL 1479 at a distance of 25 mm from fire stop material and penetration items respectively.

3.05.04 Hose Stream Test:

The intention of the hose stream test is to ascertain whether the penetration seal assembly maintains its stability on application of water jet after withstanding the fire for 3 hours i.e. the guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for carrying out the fire rating test. The penetration seal system shall be subjected to the action of hose stream at the nozzle pressure of 30 psi supplied for a duration of 1.5 sec./ sq.ft. of exposed area. The hose stream shall be applied with 1.1/ 8" dia. nozzle at a perpendicular distance of approximately 17 ft. from the centre of the assembly on a line approximately 270 deg. from the line normal to the centre for the test assembly. The water stream shall be applied within 4 minutes and 30 seconds after completion of fire rating test.

However, this period shall not exceed more than 10 minutes in case of practical difficulties experienced by testing stations. The application of water stream shall be maintained through out the test duration and shall traverse the complete fire stop system.

The fire stop assembly is deemed to have passed the hose stream test successfully if no through projection of water is noticed on the unexposed surface of the seal. Further on completion of hose stream test, the appearance of the penetration seal system shall not alter substantially indicating thereby that the stability of the system ahs been maintained.'

3.05.05 Accelerated aging test

The intention of accelerated aging test is to ascertain whether the artificial aging of the systems and components thereof results into change in the mechanical properties or in the form. In order to simulate aging, artificial aging shall be resorted to.

For the purpose of subjecting the penetrations seal system components to accelerated aging, the system / components shall be stored for 336 hours in air furnace where the temperature of the inside air, shall be maintained at 100 degree centigrade. However, for system components in pliable form, system component shall be stored for 448 hours in air furnace where temp. of air inside the furnace shall be maintained at 75°C. It is assumed that the changes occurring during test period would roughly correspond to the effect on aging over a period of about 40 years.

After completion of 336 hours / 448 hours, the mechanical properties such as tensile strength element, elongation and hardness of the material (as may be applicable) shall be tested. This results shall be compared with corresponding values before subjecting to accelerated aging test.

The change in the form of system / components shall also be compared with the form before the tests to ascertain whether the system / components thereof have undergone any permanent change.

In case the mechanical properties before and after the accelerated aging do not indicate substantial change, the system shall be deemed to have passed the accelerated aging test. Similarly the variation in the form of the system components at the end of the test shall not indicate permanent deformation which is likely to affect the ceiling properties of the system.

3.05.06 Fire Rating test After Accelerated Aging:

Intention to this test is to ascertain whether the penetration seal built out of components already subjected to accelerated aging still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test mentioned above. The assembly or the penetration seal shall be carried out with the components which were subjected to accelerated aging test based on the test procedure mentioned above. In case there is a problem of co-ordination with the test station, the prototype assembly may be subjected to aging in manufacturer's works under the conditions mentioned above and live fire test should be carried out at manufacturer's works in presence of Owner's representative.

In live fire test, the temperature of fire shall be of the order of 1000 deg.C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

The interpretation of test results for failure shall be similar to those mentioned under fire rating test/live fire test at (1) - (c) above.

3.05.07 Temperature rise test for cable in the fire stop:

This test shall be carried out to ascertain whether due to inadequate dissipation of heat at the location of fire stop, the temperature of cable conductor or outer sheath in contact with the fire stop, rises beyond the acceptable limits due to which whether any derating is required for cables.

Fire stop systems hall be erected with, at least 8-10 armoured cables, specially power cables. While laying the cable through penetration seal, thermocouple shall be placed on the outer surface of cable in contact with the fire stop system. The location shall be selected where there exists possibility of inadequate dissipation of heat from cables to the atmosphere due to fire stop components. Two thermocouples shall also be located on the two surfaces of the fire penetration seal system. Similarly thermocouples shall also be placed on the other surface of cables where there exists contact of free air without any obstruction so as to enable adequate nature cooling.

In case the temperature of outer surface of the cable in contact or inside the fire stop system does not exceed 75 degree centigrade, it is inferred that no derating of cable is required for cable when used in conjunction with the particular fire stop system.

Test shall be repeated with reduced current till the temperature of cable outer surface in contact with fire stop system is limited to 75°C. The rate of the current so guaranteed by the cable manufacturer as free air rating shall be the derating factor.

3.05.08 Water Absorption Test:

The test specimen shall be immersed in fresh clean water at a temp. of 20°C. The test specimen must be separated from the bottom and sides of the soak tank by at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hours soak period, the specimen shall be removed from the water and moped up with a damp cloth.

Fire rating test after water absorption is to ascertain whether the penetration seal subjected to water absorption still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test at Sr. No.1. In case there is problem of coordination with test stations, the prototype assembly may be subject to water absorption test at manufacturer's works followed by live fire test which should be carried out at manufacturer's works in presence of Owner's representative. In line fire test, the temp. of furnace shall be of the order of 1000°C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

3.05.09 Flame Resistance Test for fire Retardant Coating Material:

Sample strips shall be of ½ " wide, 12" long and approximately 70 mills in thick (without any reinforcement). Each strip shall be held vertically (clamped at the top) in a natural gas burner flame, (blue cone of flame touching bottom edge of sample) for 10 minutes. The flame shall then be removed and observation shall be recorded. In case, any flaming of the samples should cease after the removal of gas burner. White charred length of the sample should not exceed 1 & ½".

3.05.10 Anti-Rodent Test:

Physical tests:

a) This test shall be carried out to ascertain the anti-rodent properties of the components of the Fire proof sealing system.

b) This test shall be carried out at approved test station performing sealing system tests on pharmaceutical products. The complete Fire Proof sealing system shall be subjected to attack of inspect / vermin such as rate for about 20 days.

c) At the end of the test condition of the surface of Fire Proof sealing system the test material shall be compared with the surface condition before commencement of the test. The fire stop shall be deemed to have passed this test in case no marks of growth are seen on the surface.

3.05.11 Test Certificates

Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

The fire proof sealing system shall be installed only after receipt of approval of the test reports.

3.05.12 Testing Charges

The bidder has to indicate that unit rates for conducting the type test successfully alongwith the offer, which will be considered for evaluation of tender.

ANNEXURE-B

NOTES & DETAILS FOR GROUNDING & LIGHTNING PROTECTION SYSTEM

1.00.00 GENERAL

1.01.00 These notes and details shall be read and construed in conjunction with grounding and lightning protection drawings and specification. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The grounding and lightning protection system installation work shall conform to the requirements of the latest editions of the following standards/codes :

a) Indian Electricity Rules, 1956.

b) National Electrical Code, 1985.

c) Code of Practice for Earthing (IS: 3043)

d) Protection of Buildings and Allied Structures Against Lightning (IS: 2309)

e) IEEE 80

2.00.00 GROUNDING SYSTEM

2.01.00 Main Grounding Mat/Grid

2.01.01 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise. The size of ground grid conductor shall be bare 40 mm dia. mild steel rod (minimum). The actual diameter of ground grid conductor shall be selected by EPC contractor with back up calculation.

2.01.02 A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

2.01.03 In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

2.01.04 Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.

2.01.05 Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

2.02.00 **Grounding Electrodes**

2.02.01 The ground electrodes shall be 40 mm dia, 3000 mm long mild steel rod. These shall be fabricated and driven into the ground by the side of grounding mat conductors and connected to the ground mat conductors.

2.03.00 **Risers**

2.03.01 All risers/pigtail from the ground grid shall be 40 mm dia mild steel rod and shall be projected 300 mm above grade level/concrete floor level unless otherwise shown.

2.04.00 **Earthing Conductor**

2.04.01 75x 10 mm galvanised steel flats shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing.

2.04.02 These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground.

2.04.03 Earthing conductors along their run on column, wall etc. will be supported by suitable welding/clamping at intervals set exceeding 750 mm.

2.04.04 Earthing conductors shall be embedded in concrete floor of the building without having direct contact with the reinforcement rods.

2.04.05 At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

2.05.00 **Grounding of Equipment And Structures**

2.05.01 All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.

2.05.02 Two separate and distinct ground connections shall be provided for grounding electrical equipment frameworks in compliance with I.E. rules.

2.05.03 All Electrical equipment will be furnished with two (2) separate ground pads with tapped holes, bolts and spring washers. The connection between these ground pads and the grounding grid shall be made by short and direct earthing conductors free from kinks and splices.

2.05.04 Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.

2.05.05 The generator neutrals, transformer neutrals, earthing terminals of lightning arresters, coupling capacitor shall be directly connected to rod electrodes through riser which in turn, shall be connected to station grounding mat.

2.05.06 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors.

2.05.07 Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.

2.05.08 a) The cable trays inside the cable trenches shall be grounded thru' one (1) no. 40 mm dia M.S. Rod at an interval of ten (10) metres. One end of this rod is connected with riser from grounding mat and the other end which is projected inside the cable trench shall be connected with one (1) 50 x 6 mm G.S. flat which runs horizontally along the cable trench. This earthing conductor shall be securely attached to each tray section of cable tray/trays forming a solidly grounded tray system through 50 x 6 mm G.S. flats.

b) A continuous 50 x 6 mm G.S. flat earthing conductor shall run along the supporting structure of overhead cable trays/cable shafts. This earthing conductor shall be attached to each section of cable tray/trays through 50 x 6 mm G.S. flats.

2.05.09 Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.

2.05.10 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.

2.05.11 The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.

2.05.12 The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.

2.05.13 The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.

2.05.14 The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

2.06.00 **Earthing of Cable**

2.06.01 The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

2.07.00 **Jointing And Connection**

2.07.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

2.07.02 The bending of the large diameter ground conductor where necessary shall be done by gas heating.

2.07.03 The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

2.07.04 The connections between the riser/pigtail and earthing conductors (galvanised steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

2.07.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

2.07.06 The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GI bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

2.07.07 Equipment/structures ground connections after properly checked and tested shall be coated with weather resistant paints/cold galvanising paints.

2.08.00 The sizes and materials of ground conductors used in grounding system are listed below :

	Description	**Size**	**Material**
a)	Main Grounding Grid Conductor	40 mm dia Rod (Min)	Mild Steel
b)	Riser/Pigtail From Grounding Grid/Mat	40 mm dia Rod (Min)	- Do -
c)	Electrode	40 mm dia Rod (Min) 3000 mm long.	- Do -

Description		Size	Material
d)	Conductor used for connection of various equipment/structures as listed below		
	i) E.H.V. Substation quipment	Flats 75x 10 mm	Galvanised Steel
	Generator Frame & Gen Neutral	75 x 10 mm Flat	- Do -
	Generator Exciter Frame	75 x 10 mm Flat	- Do -
	GT, ST, UT Frame	75 x 10 mm Flat	- Do -
	GT, ST, UT Neutral	75 x 10 mm Flat	- Do –
	Aux. Power Transformer Frame	75 x 10 mm Flat	- Do -
	ii) 11 kV/3.3kV Equipment	75 x 10 mm Flat	- Do -
	iii) 11 kV/3.3kV Switchgear	75 x 10 mm Flat	- Do –
	iv) 415 V PMCC	75 x 10 mm Flat	- Do -
	v) Structures, Bus Duct Control Panels, Cable Trays etc.	75 x 10 mm Flat	- Do -
	vi) 415V Motor Control Centres, Distribution Boards etc.	75 x 10 mm Flat	- Do -
	vii) Local Panels, Lighting Panels	50 x 6 mm Flat	- Do -
	viii) Motors :		
	All HT Motors	75 x 10 mm Flat	- Do -
	LT Motor Above 90 kW	50 x 6 mm Flat	- Do -
	LT Motors Above 30 kW Upto 90 kW	35 x 6 mm Flat	- Do -
	Above 5 kW Upto 30 kW	25 x 3 mm Flat	- Do -
	Upto 5 kW	8 SWG Wire	Galvanised Iron
	ix) Miscellaneous Items, viz. Push Button Station, Junction Boxes etc.	8 SWG Wire	- Do -

Note: Sizes of GS Flat as indicated above are minimum. However Bidder shall calculate each of them and submit for approval.

3.00.00 LIGHTNING PROTECTION SYSTEM

3.01.00 Air Terminations

3.01.01 The vertical air terminal rods shall be installed at the roof of buildings (including power house main building), at the top of chimney and cooling towers to protect these objects from lightning strokes.

3.01.02 The vertical air terminal except for chimney shall be made of 20 mm dia galvanised steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

3.01.03 The air terminal rods provided at the top of chimney/stack for lightning protection shall be 20 mm dia lead coated solid copper rod.

3.01.04 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.

3.01.05 All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

3.01.06 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.

3.01.07 Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rood will be more than nine (9) metres from the nearest roof conductor.

3.02.00 Shielding Masts

3.02.01 The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house main building.

3.02.02 The shielding mast shall be made of galvanised steel pipe and the height of the same shall be decided considering the zones to be protected.

3.02.03 Each shielding mast shall be connected to grounding grid by a down conductor 75 x 10 mm. Galvanised steel flat run along the building column. In addition all power house building columns joints shall be electrically bonded.

3.03.00 **Down Conductors**

3.03.01 The down conductors shall be 75 x 10 mm galvanised steel flats. The sizes of down conductors and horizontal conductor provided for lightning protection of conveyer gallery shall be 25 x 3 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.

3.03.02 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

3.03.03 The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located at approximately 1500 mm above ground level.

3.03.04 The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall and column/structure at about 750 mm intervals unless stated otherwise in the drawing.

3.03.05 At all supports for down conductor along the column/wall of the buildings; chimney etc. the portion embedded inside the building concrete should not touch the reinforcement bars.

3.03.06 All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

3.03.07 The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

3.04.00 **Electrodes (for Lightning Protection)**

3.04.01 The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.

3.04.02 All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which will be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

3.05.00 **Riser (for Lightning Protection)**

3.05.01 All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

3.06.00 **Jointing & Connection**

3.06.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.

3.06.02 The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

3.06.03 The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

3.06.04 All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

3.06.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

3.06.06 The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

3.06.07 The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

3.06.08 The steel to copper connection shall be brazed type.

3.07.00 **Lightning Protection of 400kV GIS & Other areas**

3.07.01 The lightning protection of outdoor switchyards/substation shall be done by lightning masts on the top of steel towers. In addition, shield wires shall be used where required. The shield wire shall be strung across the top of the steel tower and/or powerhouse structure.

3.07.02 The shield wire which shall be brought down up to bottom of steel tower shall be connected to the earthing conductor (50 x 6 mm galvanised steel flat) which in turn connected to the riser (from the main grounding mat/grid).

3.07.03 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.

3.07.04 The lightning protection of conveyor gallery shall be provided with horizontal conductors (25 x 3 mm G.S. Flat) run along the length of the conveyor gallery at the top of gallery roof. This conductor shall be connected to riser and grounding electrode (40 mm dia G.S. Rods) at an approximate interval of 30 mm through two down conductions (each 25 x 3 mm G.S. Flats).

3.08.00 The sizes and materials of earthing conductors to be used in lightning protection system are listed below :

	Description		**Size**	**Material**
a)	Vertical Air Termination		20 mm dia Rod (Chimney)	Lead Coated Copper rod.
b)	Vertical Air Termination (Except Chimney)		20 mm dia Rod	Galvanised steel
c)	Horizontal Conductor	i)	75 x 10 mm Flat	- Do -
		ii)	25 x 3 mm Flat	- Do -
d)	Down Conductors	i)	75 x 10 mm Flat	- Do -
		ii)	25 x 3 mm Flat	- Do -
e)	Riser From Electrode/ Grounding Mat		40 mm dia Rod	Mild Steel
f)	Electrode for Lightning Protection		40 mm dia Rod 3000 mm long	- Do -

Note :

In addition to above, all materials as required such as G.I. pipes of appropriate length, diameter and thickness will be provided for lightning masts of Power House building and Switchyard.

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SECTION-VII

TECHNICAL SPECIFICATION
FOR
ILLUMINATION SYSTEM

CONTENT

ATTACHMENTS

SECTION-VII

TECHNICAL SPECIFICATION FOR ILLUMINATION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 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 STATION LIGHTING SYSTEM, complete with all materials and accessories for efficient and trouble-free operation.

1.02.00 The scope of work shall also include complete installation, testing, commissioning and putting into successful commercial operation of the Lighting System of Power House, Mill building, Transformer Yard, GIS building, Extension part of 400kV switchyard, CHP, AHP, Raw water system, fuel oil system Out side water pump house, Ash dyke pump house area, roads, fencing, open yard, boundary wall, Peripheral road inside boundary wall inclusive of the supply of all labour, tools, implements and supplies.

1.03.00 The major areas to be illuminated under the scope of this package are listed in Annexure-B. The areas listed are however indicative only for the purpose of guidance to the Contractor and is subject to change during detail engineering after finalization of plant layouts.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipment and materials within the scope of supply shall include but not limited to:

a) Lighting Transformer.

b) Lighting fixtures with lamps and accessories.

c) Lighting panels/boards: Main lighting boards, emergency lighting boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with energy saving system.

d) Street light poles, flood lighting tower/poles/high masts.

e) Ceiling fans, receptacles, switches, switchboards, portable emergency lights, portable 24V supply module including handset maintenance equipment etc.

f) Separate DB for 1ph, 240 V power supply is required to be indicated suitably for miscellaneous services supplies.

g) Separate DB for 24 V power supply is required to be indicated suitable for 24 V lighting supply.

h) Separate DB with transformers is required to be considered for welding receptacles.

i) Cables, wires, splicing/termination/connection accessories.

j) Conduit and accessories, junction and pull boxes, terminal blocks.

k) Grounding materials and connections.

l) All fittings, supports, brackets, anchors, clamps and connections.

m) Steel for field fabrication of supports and brackets.

2.01.01 Data sheets and technical leaflets on each piece of equipments / devices

3.00.00 SCOPE OF SERVICE

3.01.00 Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit routing, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the energy saving system.

3.01.01 Furnishing of all labour, skilled and unskilled, supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, con-summables & hardware, and transport for timely and efficient execution of the contract work.

3.01.02 Preparation of AS-BUILT drawings showing field modifications, if any.

4.00.00 GENERAL REQUIREMENTS

4.01.00 Codes and Standards

Major standards, which shall be followed, are listed below. Other applicable Indian standards even if not covered in the listed standard shall be followed.

a) IS-1913

b) IS-1977

c) IS-10322

d) IS-8623

e) IS-6064

f) IS-8828

g) IEC-598

h) IS-13703

i) IS-13947

j) IS-1248

k) IS-2705

l) IS-4160

m) IS-2713

n) IS-800

o) IS-2026

p) IS-2099

q) IS-694

r) IS-1554

s) IS-9537

t) IS-14772

u) IS-5133

5.00.00 **DESIGN CRITERIA**

5.01.00 **Design Basis**

5.01.01 The system provides lighting and electric power supply for lighting to main plant areas & transformer yard, 400KV GIS Building, Extension part of 400kV switchyard, Boiler, ESP area CHP area, raw water pump house & area, ash dyke pump house & area, boundary fencing, roads, Peripheral roads inside boundary wall etc. under the scope of this package. In addition, it also provides lighting to selected areas during plant emergency conditions.

5.01.02 The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust, fly-ash, oil/water vapours as prevalent in a thermal generating plant.

5.01.03 The design shall be such as to provide minimum lighting levels as specified for different areas.

5.01.04 The systems shall be suitable for operation on available power supply having characteristics as given in the annexure.

5.01.05 All fittings of control room / office shall be energy efficient type.

5.02.00 **System Concept**

The lighting system shall comprise following sub-systems:

5.02.01 Normal A.C. Lighting

This will be provided by A.C. lighting fixtures distributed throughout the plant area. These lights will be ON as long as the station A.C. supply is available.

A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards will be fed through respective 1:1 ratio lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB & the lighting panels shall be provided with at least 20% spare outlets.

5.02.02 Emergency A.C. Lighting

a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in selected areas of the powerhouse, boiler area, boiler galleries etc for general visibility, safe movements and operation of important auxiliaries.

b) The emergency MLDBs (EMLDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.

These lights will be kept "ON" from normal power supply source and upon its failure will be fed from DG.

c) A.C. emergency lighting fixture will account for 20% of the total lighting fixtures provided in the above mentioned area. In main control room 30% emergency lighting shall be provided.

5.02.03 Emergency D.C. Lighting

a) This will be provided by D.C. lighting fixtures located strategically in critical operating areas and emergency exits. Emergency DC lighting will be catered by DC emergency lighting distribution (DCELDB) boards. These DCELDBs will feed the DC emergency lighting fixtures directly and through a numbers of DC emergency lighting panels (DCELP) located suitably in respective areas.

b) The DC Emergency Lighting Distribution Boards will be fed from two power sources, namely -

i) Main Lighting Distribution Board (MLDB).

ii) 220V DC distribution boards (DCDB).

c) These lights will be ON all the time - normally from station A.C. Supply, but on its failure from station D.C. supply through automatic switching. On failure of AC supply connected to the panel , under voltage relay shall drop out and shall switch ON the incomer DC contractor and thus the DC supply to lighting Circuit.

d) Emergency DC Lighting to be considered for CHP shall be as follows :

Min 18 Nos. in main CHP Substation and 6 Nos. in other Substation Building/PMCC Room

Min 4 NOs. in each of the Wagon Tippler Control room

Min 2 Nos. in each floor of TPs, Crusher House, Pump House & any other areas

Conveyor Gallery/Tunnel at the rate of 30 M interval

Emergency lighting shall also be provided at entry, exit and stair cases of Electrical Sub-Station, Control Rooms, TPs, Crusher House and other buildings.

Min 10 Nos. in Each Wagon Tippler Area

Note: - For CHP area, emergency DC lighting shall be fed from DCDB. Emergency DC light shall switch on automatically in the event of failure of AC power supply.

5.02.04 24V, 1 ph AC maintenance lighting system

Separate DB for 24V power supply shall be provided for 24V maintenance lighting.

5.02.05 Street/Area Lighting

Time switch and photocell will be used for controlling area lights with provision for manual override and also have the provision of latest Energy Saving Systems.

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Same arrangement will also be used for controlling, boiler gallery, ESP area, turbine floor (high bay) area illumination.

5.02.06 Remote Emergency Lighting

This will be provided in isolated building /area/mobile equipment viz. stacker–Reclaimer where D.C. supply is not available by self-contained battery / automatic charger/inverter/flood light units. These portable emergency light units will be energized automatically on loss of normal A.C. supply.

5.03.00 **Ratings & Requirements**

5.03.01 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

5.03.02 Switch, fuses, MCCB, miniature circuit breakers (MCB), busbar shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

5.03.03 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

5.03.04 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

5.03.05 Heavy duty XLPE FRLS cables as pre cable specification will be used for connections :

a) From main lighting board to area lighting panels

b) From street/area lighting panel to street light poles.

From 415V MCCs to receptacles of 63A and above

5.03.06 The lighting system will be supplied from 415V/415V ± 5%, indoor, dry type lighting transformers. However it shall be so chosen to limit the fault level within 9kA.

5.03.07 Suitable number of Flood Lighting Towers / Lighting Masts with adequate HPSV Flood Light will be provided for necessary outdoor areas as required.

5.03.08 Lighting of all main streets, approach roads to various buildings shall be included.

5.03.09 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.

5.03.10 All A.C. Normal and Emergency A.C. lighting shall be provided with Energy Saving System.

5.04.00 **Method of Calculation**

5.04.01 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.

5.04.02 The coefficient of utilization shall be considered to take care of Lumen loss due to :

a) effect of room dimensions.

b) absorption of light in luminaires.

c) absorption of light at various room surfaces i.e ceiling wall etc.

d) floor cavity, ceiling cavity.

e) mounting height.

5.04.03 Moreover a maintenance factor shall also be considered to account for the fall of illumination due to aging, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows :

Area	**Maintenance factor**
Control Room	0.75
Switchgear/MCC Room	0.65
General indoor area	0.60

Dusty Area 0.55

Utilization factor

i) Dusty area such as conveyor galleries / Tunnels, TPS / Crusher House etc. = 50 % ceiling, 30% wall, 10 % floor.

ii) Clear areas such as switchgear room/control room etc. =70 % ceiling, 50 % wall, 10 % floor.

iii) Working plan = a) At conveyor walkway level. b) At Building floor level.

5.04.04 Lux level to be considered for various areas are given in Annexure-D

5.04.05 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.

5.04.06 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 & B is achieved.

5.04.07 At least two sub circuits shall be used for illumination of a particular area.

5.04.08 Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.

6.00.00 SPECIFIC REQUIREMENTS - SUPPLY

6.01.00 Equipment and Material

6.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

6.01.02 Equipment and materials furnished shall be complete and operative in all details.

6.01.03 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

6.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

6.02.00 Lighting Transformers & Lighting Fixtures

6.02.01 Lighting transformers shall be dry type, indoor type dusty vermin proof having 415 V/415 V ± 2 x 2.5% with off load tap-changer on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.)The casing of the transformer shall be grounded at least at two (2) points.

6.02.02 If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

6.02.03 Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.

6.02.04 Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.

6.02.05 Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth wire connection.

6.02.06 High bay fixtures shall have provision for vibration damper to ensure rated lamp life. Cost of each damper shall be separately indicated.

6.02.07 Fixture shall be furnished complete with lamps and integrally/non integrally or separately mounted control gear & accessories as applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, ignitors etc.

6.02.08 Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop out connection of PVC wires of following sizes :

a) Lighting fixture : 2.5 mm^2 Copper

b) Flood Light fixture : 2x2.5 mm^2 Copper

6.03.00 **Lamps**

6.03.01 General lighting service (GLS) lamps shall be with clear glass and screwed caps.

6.03.02 All fluorescent lamp shall be bi-pin rotary type. Lamp holder shall be spring loaded, low contact resistance type and shall have resistance to wear. CFL and T5 fluorescent tube with electronic ballast or tri-phosphorous tube

Fluorescent lamp will be used in indoor application having low height like 3 to 5 metres requiring good colour rendering. All control rooms, electrical panel room, auxiliary building, laboratories, office area, etc. will be provided with fluorescent lamp fixtures. The fluorescent lamp will be tubular, cool daylight type of 28W as per annexure.

6.03.03 Mercury/Sodium vapour lamp shall be colour corrected type with screwed cap.

HPSV lamp has the advantage of very high efficiency (lumens/watt) and hence recommended for indoor application with elevation more than 4 meters such as TG Hall, Boiler & ESP platform, Pump House and all outdoor application such as area lighting, roads, boundary wall, etc. Flameproof fixtures will be used for hazardous areas with HPMV lamps. The HPSV/ HPMV lamps will be elliptical of rating 70W/150W/250W/400W as required depending on application.

6.03.04 Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.

6.04.00 **Ballast/Electronic Ballast**

6.04.01 Ballasts shall be heavy duty, low loss, polyester-filled type with copper winding.

6.04.02 Ballast for Mercury/Sodium vapour lamp shall be provided with suitable tapping to set the voltage within range specified.

6.04.03 Ballasts shall be free from hum. Ballasts, which produce humming sound, shall be replaced, free of cost, by the Contractor.

6.04.04 In multi-lamp fixture, each lamp shall be provided with individual ballast.

6.04.05 Ballast windings shall have maximum operating temperature of 120^{o}C without rated temperature rise marking.

6.04.06 Electronic Ballast shall be suitable for 220 V DC and also 240 V AC.

6.04.07 Electronic Ballast shall be compact, lightweight, high frequency electronic standard ballast for fluorescent lamps.

6.04.08 It shall be Flicker-free warm start, ideal for areas with high switching frequency.

6.04.09 Electronic Ballast shall be of such design that minimum 25% reduction in energy consumption at constant luminous flux compared with conventional gear.

6.04.10 Electronic Ballast shall not be caused to high harmonic distortion.

6.04.11 Electronic Ballast shall provide constant light independent of mains voltage fluctuation.

6.05.00 **Lighting Panel/Distribution Boards**

6.05.01 Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated from CRCA sheet steel minimum 2 mm thick, suitable for either wall/column mounting on brackets or floor mounting on channel sills.

6.05.02 Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-52 or better; outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle-housing transformer shall be minimum IP-42.

6.05.03 Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

6.05.04 Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.

6.05.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.

6.05.06 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.

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 aluminium with inscriptions indelibly etched on it.

6.05.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85ºC. Minimum size shall be 25 x 6 mm.

6.05.08 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

6.06.00 **Board/Panel Equipment**

6.06.01 Each Distribution Board shall consist of one dry type transformer housed in the cubicle voltmeter with selector switch, C.T. operated ammeter and incoming triple pole MCCB. Outgoing feeder from the Lighting Distribution Board shall have MCCB. Proper discrimination between outgoing MCCB of Lighting Distribution Board and downstream MCCB of Lighting Panel should be ensured.

6.06.02 Each panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB) as per annexure.

6.06.03 Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.

6.06.04 All MCCB shall be single throw, air break, heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type. Contactors shall be air break electromagnetic type. Push buttons shall be push to actuate type.

6.06.05 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

6.06.06 Time switch in street lighting panels shall be clock switch type with ON-OFF time setting facility, which shall ensure respective ON-OFF operation in every 24 Hours cycle. Voltmeter/Ammeter shall be of accuracy class 2.0 or better as per IS: 1248. Voltmeter/Ammeter selector switch shall be of reputed make.

6.07.00 **Receptacles**

6.07.01 Receptacles shall be heavy duty, complete with individual plug and switch as detailed in the annexure.

6.07.02 The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.

6.07.03 Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

6.07.04 Receptacles to be chosen for CHP system :

a) 5 Amp, 240 V, 2-Pole, 3-Pin type suitable for flush mounting in MCC & Control Room. The switch shall be of Piano-key type.

b) 15 Amp. 240 V, 2-Pole, 3-Pin industrial type receptacle shall be provided in MCC room, control room, TP's, conveyor gallery/tunnel at an interval of 75 M along the length of the conveyor gallery/tunnel. Minimum one (1) no shall be provided in all equipment floor, TP's, Sub-Station, Cable Spreader Room, Crusher House, Pump House, etc. In each circuit from lighting panel maximum (5) nos. loop-in-loop-out connection shall be considered.

c) 63 Amp, 415 V, 3-Ph., 4-Pin industrial type interlocked plug and switch with earthing contact receptacle shall be provided in MCC room, Control room,, conveyor tunnels/galleries, Wagon Tippler area and one (1) no. in all equipment floor of TP, Sub-Station, Cable Spreader Room, Crusher House, Pump House, etc.

6.08.00 **Fans & Regulators**

6.08.01 The fans shall have three well balanced blades, and shall be reasonably free from noise. Pedestal fans shall also be provided as per requirement.

6.08.02 Fan motor shall be totally enclosed type with copper winding and class E insulation.

6.08.03 Regulator shall have minimum five steps. Electronic regulator with smooth control is to beprovided.

6.09.00 **Switch & Switch Board**

6.09.01 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.

6.09.02 Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.

6.09.03 Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.

6.09.04 Flush type receptacles where provided shall be so located that only the plug projects outside.

6.09.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.

6.10.00 **Lighting Poles & Flood Light Tower**

6.10.01 Street Light Poles

a) Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.

b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).

6.10.02 **Flood Light Tower**

a) Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.

b) Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800.

6.10.03 **Lighting High Masts**

Applicable standards :

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

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

Structure :

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

The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool,

luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

6.11.00 **Maintenance Equipment**

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

6.11.02 For the maintenance of lighting fixtures within the power house, the contractor shall also supply four (4) nos. free standing adjustable aluminium ladder, adjustable from 5m. to 10m.

6.12.00 **Special Requirement**

6.12.01 All outdoor illumination fixtures, unless it is fed from photo cell/time switch controlled lighting panel, has to be provided with outdoor type local switches.

6.12.02 In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied and the wiring & fixing of the same has to be done by the contractor.

6.13.00 **Lighting Cables & Wires**

6.13.01 Lighting Cable shall be heavy duty, 1100 Volt grade, multicore stranded aluminium conductor, XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLS conforming to IS 1554.

6.13.02 Lighting wires shall be 1100 Volt grade, fire resistance PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED	for	R-Phase	BLACK	for	Neutral
YELLOW	for	Y-Phase	WHITE	for	+'Ve D.C.
BLUE	for	B-Phase	GREY	for	-'Ve D.C.

6.13.03 Wire size shall be as follows :

For point wiring beyond lighting panel i.e from lighting Panel to junction box (main run)	:	10 Sq.mm. Aluminium. Stranded conductor
From Junction box to lighting fixture	:	2.5 Sq.mm. Copper Stranded conductor

6.14.00 **Conduits and Accessories**

6.14.01 Conduits shall be rigid steel, hot-dip galvanised, furnished in standard length of 3 metres, threaded at both ends.

6.14.02 Thickness of conduits up to and including 25 mm dia shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 20 mm.

6.14.03 Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

6.14.04 Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips and coated with PVC.

6.15.00 **Junction Box**

6.15.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanised, dust and damp proof, generally conforming to IP-55.

6.15.02 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.

6.15.03 Junction boxes for outdoor use shall be weatherproof IPW-55 and those for hazardous location shall be flame-proof type.

6.15.04 Junction boxes shall have following indelible markings :

Circuit nos. on top

Circuit nos. with ferrules (inside) as per drawing

DANGER sign in case of 415V circuit

6.16.00 **Terminals**

6.16.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

6.16.02 Each terminal shall be suitable for connection up to 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.

6.17.00 **Portable Emergency Lighting Unit**

The portable emergency lighting unit shall be complete with 6 volt storage battery (rechargeable), inverter, automatic charger, twin 6 watts fluorescents tube lamp and test switch. Contractor shall furnish make, type and catalogue.

6.18.00 **24 V Supply Module**

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 and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 6A, 24V AC receptacles located near Boiler access doors and condenser area shall be wired up from 24V side of each 24V A.C. supply module.

The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.

6.18.01 Minimum15 nos. portable 24 V AC supply modules having sheet steel enclosure with louvers as per above shall be supplied for all the threel units 24V halogen automobiles lamps with reflector along with 1100 V, twin core PVC sheathed, 2.5 mm^2 stranded copper wire of 20 m lengths as handset .

Exact requirement will be finalized during detail engineering and accordingly the bidder shall furnish the same.

6.19.00 **Nameplate**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to clearly indicate their functions.

All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

6.20.00 **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.

6.21.00 **Energy Saving System**

6.21.01 **Panels**

The energy saving system panel shall consists of loss less reactance coils with voltage tapping, contactor to select the tap, Micro-processor based TIMER along with real time clock for activating the contactor at a pre-set time. The unit shall be programmable so that at a pre-set time contactor on the lower voltage tap can be selected and reduced voltage can be applied across the circuit. It shall also be possible to modify the setting at site, if required.

The capacity of panels shall be 25/30 kVA or more as required. This system shall be incorporated in normal AC panels and Emergency AC panels.

7.00.00 SPECIFIC REQUIREMENTS - SERVICES

7.01.00 Consumables and Hardware

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

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

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

b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

7.01.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.02.00 **Testing Equipment**

7.02.01 The Contractor will provide such checking and testing equipment as test lamp, buzzer, 500-volt meggar, earth meggar, lux-meter etc. and also other testing equipment as required.

7.03.00 **Installation - General**

7.03.01 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

7.03.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.04.00 **Lighting Fixtures**

7.04.01 Continuous rows of fluorescent tubes shall be mounted on a continuous M.S. angle for each row of lights.

7.04.02 In turbine hall, fixtures shall be mounted to maintain sufficient clearance from the overhead travelling crane trolley.

7.04.03 In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.

Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity.

If a roof over platform is available, the fixture can be pendant mounted.

7.04.04 Floodlights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture about 5 Deg on both sides. Bolts shall be finally tightened with spring washer.

The Contractor shall supply and install the steel base for fixing the flood light on the flood light towers.

Terminal connection to the floodlight shall be made through PVC coated flexible metallic conduits.

7.04.05 Fixtures shall be mounted on sub-station structures with suitable clamps. No cutting or drilling of sub-station structures is permitted.

7.04.06 The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

7.05.00 **Receptacles**

Receptacles shall be installed at locations shown in approved drawings.

7.06.00 **MLDB, EMLDB DCELDB and Lighting Panel**

7.06.01 MLDB, EMLDB DCELDB and Lighting panels shall be erected at the locations indicated in approved drawings.

7.07.00 **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 contractor.

7.08.00 **Conduit System**

7.08.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.

7.08.02 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.

7.08.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

7.08.04 Conduits shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be fixed to the building steel by welding and to concrete or brick work by grouting as shown on drawings.

Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

7.08.05 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

7.08.06 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.

7.08.07 Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.

7.08.08 For directly embedding in soil, the conduits shall be coated with an asphalt - base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

7.08.09 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

7.08.10 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.

7.08.11 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.

7.08.12 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

7.08.13 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.

7.08.14 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.

7.08.15 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.

7.08.16 Conduit joints and connections shall be made thoroughly water-tight and rust-proof by application of a thread compound which will not insulate the joints.

White lead is suitable for application on embedded conduit and red lead for exposed conduit.

7.08.17 The Battery Room installation shall be made with acid fume proof conduits.

7.08.18 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.

7.08.19 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

7.08.20 Lighting fixture shall not be suspended directly from junction box in the main conduit run.

7.08.21 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.

7.08.22 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

7.08.23 In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.

7.09.00 **Wiring**

7.09.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

7.09.02 Wire shall not be pulled through more than two equivalent 90º bends in a single conduit run.

7.09.03 Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.

7.09.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

7.09.05 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.

7.09.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.

7.09.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

7.09.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

7.10.00 **Cabling**

7.10.01 In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the over ground portion.

7.10.02 Buried cables shall be laid and covered with sand/ riddled earth, and protected from damage by bricks at sides and pre cast 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.

7.10.03 When burried cables cross road/railway track, additional protection to be provided in form of hume / G.I. pipe.

7.11.00 **Grounding**

7.11.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.

7.11.02 Ground connections shall be made from nearest available station ground grid. All connections to ground grid shall be done by arc welding.

7.11.03 Panels/Boards shall be directly connected to ground grid by two nos. 35 x 6 mm G.I. flats (for panels) / two nos. 50x6 mm G.I. flats (for distribution boards).

7.11.04 All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 16 SWG G.I. wire.

7.11.05 Each street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.I 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 GI wire. One 16 SWG G.I wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.

7.12.00 **Foundation & Civil Works**

7.12.01 Equipment foundations, panel foundations and all other civil work will be provided by the Contractor.

7.13.00 **Excavation and Back Filling**

7.13.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

7.13.02 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.

7.13.03 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

7.13.04 All excavation shall be backfilled to the original level with good consolidation.

7.14.00 **Steel Fabrication**

7.14.01 All supports, hangers & brackets shall be fabricated by the Contractor. Necessary steel shall be supplied by the Contractor.

7.14.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

7.14.03 Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated.

7.15.00 **Painting**

7.15.01 Street light poles shall be given two coats of aluminium paints after installation.

7.15.02 All steel fabrication shall be given two coats of redoxide primer followed by two coats of battleship Siemens gray RAL-7032.

7.15.03 All equipment shall be given touch-up paint as required after installation.

7.16.00 **Inspection & Testing**

7.16.01 On completion of erection works, the Contractor shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.

7.16.02 The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

7.16.03 The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

7.16.04 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

8.00.00 TESTS

8.01.00 Shop Tests

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on lighting Distribution Boards/Panels shall include :

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

8.02.00 Site Tests

8.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove that the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.02.04 Illumination in different areas are as per designed lux level should be established.

8.03.00 Test Certificates

a) 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.

b) The equipment shall be dispatched from works only after receipt of Owner's written approval of shop test reports.

c) Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 Drawings, data and manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in the General Condition of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

9.02.00 **To be submitted with the Bid**

9.02.01 Make, type and catalogue number of lighting fixtures, lamps and accessories along with technical leaflets, data sheets, polar curves etc.

9.02.02 Typical outline drawings, showing constructional features, cable/ conduit entry, fixing arrangements etc of :

a) Lighting Distribution Board & Panel/receptacles/junction boxes.

b) Street light pole.

9.02.03 Technical leaflets and data sheet on each piece of equipment / device such as MCB, switch fuse, MCCB, receptacle etc.

9.02.04 Type test certificates on lighting fixtures and lighting panels, transformer, ballast, power cables.

9.03.00 **To be submitted after Award of Contract**

9.03.01 Detail dimensional drawing showing constructional features, cable/ conduit entry, grounding, fixing arrangement etc. of:

a) Lighting panels & distribution boards.

b) Receptacles & Junction boxes.

c) Street light poles.

d) Lighting fixture complete with lamps and accessories.

e) Non-integral/separate type control gearbox for lighting fixtures, as applicable.

9.03.02 Data sheets for lighting fixture, lamps, accessories with light distribution curves, co-efficient of utilization charts etc. Type and routine test certificates of transformer and cables.

9.03.03 Control schematic and wiring diagram of 415V AC/220V DC lighting panel with automatic changeover from AC to DC and vice-versa, 415V normal AC Street/area lighting panel with automatic ON/OFF feature.

9.03.04 Technical leaflets and data sheet on each piece of equipment/ device such as MCB, switch, fuse, receptacle etc. Type and routine test certificates of transformer and cables.

9.03.05 Lighting layouts showing the disposition of fixtures, lighting panels/boards, circuit distributions, conduit & wire routing.

9.03.06 Key Single Line Diagram for lighting distribution, board wise single line diagram with feeder loading, cable schedule and interconnection chart, design calculation for lighting.

9.03.07 AS-BUILT lighting layout and erection drawings, properly incorporating the changes/alterations/field modifications, if any, as carried out at field along with circuit distribution schemes of all lighting panels, conduit and cable routing and as acceptable to the Owner.

9.03.08 Any other relevant drawings, data and manuals necessary for satisfactory installation, operation and maintenance.

9.03.09 The Bidder may note that the drawings, data and manuals listed are minimum requirement only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.

ANNEXURE-A

AVAILABLE POWER SUPPLY

1.0 **System Voltage**

Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources:

1.1	A.C. Supply	:	415 Volt, 3 phase, 50 Hz, 4 wire effectively grounded system. Fault Level 50 KA r.m.s. symmetrical.
1.2	D.C. Supply	:	220 V, 2 wire, ungrounded system. Fault Level 25 * KA

2.0 **Permissible Variation**

Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:

2.1	A.C. Supply	:	Voltage $\pm$ 10% Frequency $\pm$ 5% Combined Voltage + Frequency 10% (absolute sum)
	D.C. Supply	:	Voltage 187 to 242 Volt.

* Indicative only; actual value will be decided by the Bidder after substantiating the same by calculation.

ANNEXURE-B

BROAD LIST OF AREAS TO BE ILLUMINATED

Purpose of this list is to give general guidance on major areas to be illuminated. The list is however not exhaustive. Illumination engineering shall be done by the Contractor based on the detail layout developed for rooms/areas during detail engineering and considering the guidance provided in Lighting Notes & Details.

1. Power House Building
2. Transformer Yard for GT, ST, UT, UAT & SATs.
3. GIS Building
4. Boiler Area for Units, Boiler galleries, platforms, stairs.
5. E S P
6. E.S.P Control Building
7. D.G. Plant Building (Part of Power House)
8. Service Building (Centralized Control Rooms)
9. C.W and ACW Pump House.
10. C.W. Chlorination Plant Building
11. Mill Bay
12. All roads in the transformer yard including approach roads (as will be finalized during detail engineering), general area.
13. Chimney
14. DG & Compressor BLDG.
15. Bottom & Coarse slurry P.H. & Elec. Room
16. ASW pump house & Elec. Room
17. Vacuum pump shed & MCC room
18. HFO & LDO pressurizing pump house
19. Fly ash conveying Comp. BLDG. & Elec. Room
20. Open yard
21. Store
22. Canteen
23. Work shop
24. Weight bridge
25. Cooling tower
26. DM plant
27. Wagon tippler
28. Wagon tippler CTRL. Room
29. Pent house
30. Crusher house

31. CHP control room
32. Coal stock pile
33. HCSD & Art tank
34. Silo utility room
35. MCC cum ctrl. Room of HCSD system
36. F.O.P.H. & foam shed
37. ETP
38. In plant raw water reservoir & PH.
39. Fire station
40. Pretreatment & filtration plant
41. TTW & FW pump house
42. Plant area STP
43. ADMN. BLDG
44. Check post
45. Secondary gate
46. Ash gate
47. CW treatment BLDG
48. Loco shed
49. Peripheral road inside boundary wall.
50. Extension part of 400kV switchyard
51. Illumination of 6.5 metre wide RCC Road from proposed Ash dyke to existing Brick Plant (approx. 1200 metre length) in between 800E & 450W

NOTE: Illumination System Excluded from Bidder's Scope of Work:

1. Illumination System of outside plant boundary area of Ash Slurry / HCSD piping corridor and Illumination of Ash Pond I, II & III.
2. Illumination System of Fuel Oil Transfer pipe corridor along side of existing fuel oil transfer pipe corridor.
3. Illumination System of Railway Marshalling Yard

ANNEXURE-C

TYPES & BOM OF LIGHTING FIXTURES & LAMPS

Each lighting fixture shall be furnished complete with associated lamp, holder and control gear fully wired up. Control should include copper ballast, copper choke, capacitor starter, electronic-igniter (separate type), fuse connector block etc.

For well glass fittings for HPSV lamps higher wattage (250/400 W) floodlight luminaire, the control gear will be separate/non-integral type whereas for high bay, streetlight and mini flood light fixture, the control gear shall be integral type.

Sl. No.	Type	Wattage/ mains Voltage	Description
1.1	A(1)	1x100 W GSI 240 V AC 220 V DC	Industrial bulkhead luminaire, suitable with 1x GLS 100 W incandescent lamp. The luminaire should comprise of single piece pressure die cast aluminium housing and cover retaining frame made of LM6. The housing should be stove enameled white inside. The luminaire should have heat resistant toughened frosted gals cover along with a gasket made of EPR to ensure insect free satisfactory performance without ingress of water. A powder coated m.s. wire guard and all other accessories suitable for ceiling/wall mounting. (For use in inside area)
1.2	A(0)	1x100 W GSI 240 V AC 220 V DC	Well glass luminaire, dust proof & rain proof, light weight pressure die cast aluminium housing LM6 painted gray outside and white inside, with porcelain lamp holder (E-27) along with an earthing terminal heat resistant toughened clear glass cover with gasket made of EPR, pressure die cast Al. (LM6) ring hinge to the housing, powder coated ms wire guard mounting provision suitable for suspension by means of dia. 20 mm threaded GI pipe. The fixture should conform to degree of protection IP-65 (min)
1.3	DC (cmp)	1x100 W Comptalux 240 V AC 220 V Dc	Recessed downlight luminaire with asymmetric beam suitable for use in non-ventilated false ceiling. The luminaire should comprise sealing ring made of aluminium, pressure die cast. The frame with adjustable mounting clamps should be made of m.s. and zinc plated. The reflector should of high purity aluminium sheet electro chemically brightened and anodized. The luminaire should have E27 porcelain lamp holder fixed to nylon connector system pre-wired up to terminal block. The mounting clamps should be such so as to be adjusted according to the ceiling thickness for easy installation for different ceilings.
1.4	DA	2x28 W (228) Fluorescent lamp 240 V AC	Decorative type, Recessed mount, FTL Luminaires comprising epoxy powder coated CRCA housing, mirror optics aluminum anodized reflector, with anti-glare feature, louvers with aluminum transverse fins, completely wired with electronic ballast and starters, PF capacitor and connector suitable for 2x28W tubular fluorescent lamp.
1.5	DB	1x28	Decorative type, Recessed mount, FTL Luminaires

Sl. No.	Type	Wattage/ mains Voltage	Description
		Fluorescent lamp 240 V AC	comprising epoxy powder coated CRCA housing, mirror optics aluminum anodized reflector, with anti-glare feature, louvers with aluminum transverse fins, completely wired with electronic ballast and starters, PF capacitor and connector suitable for 1X28 tube lamp.
1.6	DC	2x9 CFL 240 V AC	Decorative type, Recessed mount, CRCA housing, aluminum anodized reflector, fitted with painted aluminium lamelle suitable for 2x9W PL lamp.
1.7	DF	2x28 Fluorescent lamp 240 V AC	Industrial, Ceiling or Suspension mount, FTL Luminaries comprising of stove enamelled steel sheet reflector, completely wired with electronic ballast and starters, PF capacitor and connector suitable for 2x28W tubular fluorescent lamp.
1.8	FP	1x125W HPMV 240 V AC	Flame proof luminaire : Well glass non-integral flame proof fixture die cast aluminium LM 6 housing enamel heat resistant toughened well glass, with hot dip galvanized wire guard a spi-gotted terminal cum lamp holder plate made of LM6 with an E 27 type porcelain lamp holder 1X19mm BSC/ET cable entry with an option ceiling/wall mounting or suspension with a bracket or an eye bolt Separate flame proof control gear enclosure of die cast aluminium housing with cover, chain suspension for the cover assembled with all accessories and loop in loop out arrangement. All termination within the control gearbox should be suitable for explosive environment. The fixture & control gear should be suitable for use in hazardous area zone-1& zone-2 as per IS 5572(part I)-1978 and for explosive environment of gas Group-IIA & II B as per IS 2148-1981. Degree of protection IP55
1.9	LB	1x150/250W HPSV 240 V AC	Well glass luminaire, dust and jet proof, light weight housing made of corrosion resistant die cast aluminium alloy in conjunction with separate control gearbox. Housing should be stove enameled gray outside white inside after application of epoxy base primer, a porcelain lamp holder (E-40 type) prewired up to terminal block located inside the housing along with earthing arrangement. The luminaire should suitable for suspension by means of threaded G.I. Pipe of 20 mm bore and also for 'j' bracket mounting. A glass cover made of heat resistant glass (annealed) provided with EPR gasket encased in die cast aluminium ring hinged to the housing. Should have external vitreous enameled reflector. Degree of protection-IP 55 (min) for luminaire and IP 54 (min) for control gear.
1.10	LD	1x70W HPSV 240 V AC	Well glass luminaire, similar to above but suit able for 70W HPSV lamps. Luminaire shall have external M.S. sheet steel vitreous enameled reflector with integral control gear, degree of protection IP 65 (Minimum).
1.11	HB	1x250/400 W	High bay luminaire industrial closed version luminaire with

Sl. No.	Type	Wattage/ mains Voltage	Description
		HPSV 240 V AC	painted die cast aluminium housing accommodating vibration proof E-40 lamp holder with a provision for adjustment to obtain narrow/wide beam distribution, painted die cast aluminium mounting tray accommodation ballast, capacitor and igniter all pre wired up to the terminal block, a chain to suspend the housing, a cable entry gland or grommet for entry of incoming cable and an internal earthing. An anodized spun aluminium spacer between housing and reflector and high purity/a glass reflector electro-chemically brightened and anodized flat toughened glass fixed to the reflector by toggle to suspend the glass cover, an eye bolt of Zinc plated and passivated M.S. Degree of protection IP-52 (min)
1.12	MB (150)	1x150W 240 V AC	Medium bay luminaire- similar to HB above expect suitable for lower mounting height with 150W HPSV lamps.
1.13	EL	1x20W 240 V AC	Escape lighting luminaire with "EXIT" sign type i.e. EXIT sign always visible fitted with 1x20 fluorescent tube. Each luminaire shall be self contained 6 volt battery, battery charger unit. Normally the luminaire shall be ON continuously through 240V AC supply. When AC supply goes OFF the in built battery & inverter system automatically takes on to ignite luminaire for duration of two & half (2½) hours. The battery shall be maintenance free and shall be trickle charged when 240 V AC mains supply is available.
1.14	NY	1x150/250W HPSV 240 V AC	Street light luminaire-weather proof having housing made of corrosion resistant LM6 die cast aluminium epoxy powder coated in an attractive grey colour out side. Specially developed pot mirror optimized for use with tubular lamp of high purity aluminium, electrochemically brightened and anodized, copper etc. accommodated in gear compartment of housing. Long life neoprene gasket, to avoid entry of insects, cover made of acrylic. Degree of protection-IP-43 suitable for 150 SV lamps.
1.15	DL	2x28W Fluorescent 240V AC	Industrial, Ceiling or Suspension mount, FTL Luminaries comprising of stove enamelled steel sheet reflector, completely wired with electronic ballast and starters, PF capacitor and connector suitable for 2x28W tubular fluorescent lamp. Lighting fixtures are totally enclosed corrosion proof type.
1.16	DE	1x28W /2x28W Fluorescent 240V AC	Dust, Drip & water proof FTL luminaries, aluminum housing with canopy, acrylic cover, completely wired with electronic ballast and starters, PF capacitor and connector suitable for 1x28W / 2x28W tubular fluorescent lamp.
Note:1	The supply also includes associated junction boxes, brackets, supports, hangers, and wires wherever applicable.		
2.0	**LIGHTING BOARD/PANEL**		
2.1	MLDB & EMLDB		415 V A.C. Indoor type Lighting distribution board with transformer (details in Annexure-E), 415 V, 200A, 3 ph, 4 wire bus, one 200A triple pole switch as incomer, 8 Nos. 100A, TP & N switch and fuse as outgoing feeders.
2.2	DCELDB		Indoor type Emergency Lighting Distribution Board with

Sl. No.	Type	Wattage/ mains Voltage	Description
			100A, 415 V TPN bus, 1 no. 100A TP & N switch fuse as A.C. incomer, 1 no. 100A D.P. switch fuse as D.C. incomer and 18 nos. 20A, 2 pole MCB with back-up fuse as outgoing feeders complete with auto change over control circuit, push button, indication lamp, etc. with provision for manual override & test facility to test all emergency circuit.
2.3	LP-1		415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch as incomer, 18 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
2.4	LP-2		415 V A.C. Indoor Lighting panel with 415 V, 3ph, 4W bus & one 63A TP & N Switch as incomer and 12 nos 20A , 240V 1 pole MCBs as outgoing feeder.
2.5	LP-3		415V A.C. Indoor type Lighting Panel with 415V, 63A, 3 ph, 4 wire bus, one (1) no. 32 A TP&N switch as incomer, 6 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.
2.6	SLP		415 V A.C. Outdoor type Panel with 415 V, 100A, 3 ph, 4 wire bus, one 100A TP & N switch as incomer, 18 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.
			The lighting panel shall be provided with 63A contactor, frequency compensated timer switch, photo-cell switch push- buttons for automatic control of street/area lighting with provision for manual override.
2.7	DCELP		Indoor type emergency lighting panel with 240V bus, one no 20A switch fuse as incomer and 6 nos 16A two pole MCB with back up fuse as outgoing feeders.
2.8	FLP		Outdoor, lookable type Isolating switch of 415V, 32A, 3 ph, 4 wire TP & N. with 2 mm sheet steel/cast iron cubicle.
3.0	RECEPTACLE		
3.1	RA		6A, 240 V, 2 pole, 3 pin with third pin earthed, suitable for flush mounting in office areas and control room. the switch shall be also flush mounted piano type.
3.2	RB		16A, 240V, 2 pole, 3 pin with third pin earthed, wall/ column mounted, metal clad gasketed construction, 20mm conduit entry, screwed metal cover tied to it by a metal chain, weatherproof suitable for indoor/outdoor installation.
3.3	RC		63A, 415 V, 3 phase, 4 pin interlocked plug and switch with earthing contact, wall/column mounted, metal clad gasketed construction, weatherproof, suitable for loop-in/loop-out connection of 4/C-35 Sq.mm XLPE cable. These shall be fed from AC Distribution Board/Station MCC.
3.4	RD		125 A, 415 V, 3 phase 5 pin interlocked plug & switch with fifth pin earthed, wall/column mounted metal clad gasketed construction, weatherproof, suitable for loop in and loop out connection of 3-1/2C -95 Sq.mm XLPE cable. These shall be fed from A.C-Distribution Board/Station MCC.
4.0	CEILING FANS		
4.1	FA		1200 mm sweep ceiling fan with regulator, down rod and

Sl. No.	Type	Wattage/ mains Voltage	Description
			canopy.
4.2	FB		1400 mm sweep ceiling fan with regulator, down rod and canopy.
5.0	LIGHTING POLES		
5.1	TA/TB		Single arm/double arm swaged and welded steel pole with junction box and all accessories.
6.0	SWITCHBOARD		
6.1	S-1		Switch board with 1-5A switch.
6.2	S-2		Switch board with 3-5A switch and 1-5A receptacle.
6.3	S-3		Switch board with 6-5A switch and 1-5A receptacle.
7.0	MISCELLANEOUS ITEMS		
7.1	M1		10 m high car wheel mounted aluminium ladder.
7.2	M2		Adjustable free-standing aluminium ladder height adjustable from 5 m to 10 m.
7.3	M3		Portable Emergency light set complete with one 20W tube light, battery, battery charger and all other accessories.
7.4	M4		24 Volt Supply Module with all accessories.

ANNEXURE-D

ILLUMINATION LEVEL

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
1.0	**Turbine Generator Building :**			
1.1	General Auxiliary Equipment Areas	100	Industrial Well Glass	70W/150W HPSV/125 W HPMV Lamp
1.2	Cable Spreader Room	70	Industrial type fluorescent lamp with vitreous enamel reflectors	Fluorescent tube (T5) with electronic ballast.
1.3	All Switchgear Room Area	200	Industrial type fluorescent lamp with vitreous enamel reflectors	Fluorescent tube (T5) with electronic ballast.
1.4	TG Building Operating Floor	200	Industrial Integral high bay	250 W/400W HPSV / HPMV lamp
1.5	Main Control Rooms	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28W FTL
1.6	Battery Rooms	200	Industrial Corrosion proof luminarie.	2 x 28W FTL.
1.7	Unloading and Maintenance bay	250	Industrial integral high bay	250 W / 400W HPSV /HPMV lamp
2.0	**Boiler Area :**			
2.1	Boiler area and platforms	100	Dust proof / dust tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
2.2	Coal Bunker and Mill bay area	100	Dust proof / dust tight integral well glass luminaire	1 x 80 W /125 W HPMV lamp
2.3	ESP areas and Platforms	100	Dust proof / dust tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
2.4	ESP Control Room	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28 W FTL.
Sl.No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
3,0	**Transformer Yard :**			
3.1	General	20	General purpose flood light	250 W/400 W HPSV lamp
3.2	Near equipment	50	Dust proof / dust tight	1 x 70 W HPSV

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
			integral well glass	lamp
4.0	**GIS Building :**			
4.1	General Indoor Area	200	Industrial type fluorescent lamp / Industrial Integral high bay or Medium bay	fluorescent tube (T5) with electronic ballast/250 W/400W HPMV lamp
4.2	Near Local Control panel	300	Industrial type fluorescent lamp	fluorescent tube (T5) with electronic ballast
5.0	**Various Off-site Buildings :**			
5.1	Equipment Room / Switchgear Rooms	200	Industrial type fluores-cent lamp with vitreous enamel reflectors up to mounting height of 3.5 M or Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M.	fluorescent tube (T5) with electronic ballast
5.2	Pump Houses	200	Industrial well glass	70 W HPSV/ 125W HPMV lamp
6.0	**Cooling Water Pump House Area :**			
6.1	Cooling Tower Area	30	Industrial well glass	70 W HPSV/ 125W HPMV lamp
6.2	CW PH	200	Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M	70 /150 W HPSV or 150 / 250 W HPMV lamp
7.0	**Road & Yard Lighting:**			
7.1	Main Roads	20	Integral type street Lighting luminaire with aluminium reflector	150 /250W HPSV lamp
7.2	Secondary Roads	10	-do-	-do-
7.3	Perimeter (Compound) Lighting	10	-do-	-do-
8.0	**Service Building, Canteen, Annex. Building etc.**			
8.1	Main Office /Staff Room	300	Decorative recess mounted mirror optics aluminum anodized reflector	2 x 28W FTL
8.2	Non-Office /Service Areas	300	Decorative recess / surface mounted/ Suspended type mirror optics	Fluorescent tube (T5) with electronic ballast.
9.0	**General :**			
9.1	Corridors, Walkways,	70	Industrial type	Fluorescent tube

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
	Staircase, Lockers etc.		fluorescent lamp with vitreous enamel reflectors	(T5) with electronic ballast.
9.2	Toilets, Wash Rooms, etc.	70	Commercial channel mounted box type	Fluorescent tube (T5) with electronic ballast.
10.0	**Extension part of 400kV SWYD :**			
10.1	Control Room	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28W FTL
10.2	Switchgear/Electrical Equipment room	200	Industrial type fluores-cent lamp with vitreous enamel reflectors up to mounting height of 3.5 M or Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M.	fluorescent tube (T5) with electronic ballast
10.3	Battery Room	200	Industrial Corrosion proof luminarie.	2 x 28W FTL.
10.4	Outdoor Operating Area	50	General purpose flood light	250 W/400 W HPSV lamp
10.5	General Outdoor Area	20	General purpose flood light	250 W/400 W HPSV lamp
11.0	**CHP Area**			
11.1	Transfer Point, Conveyor gallery, pent house, tunnel, Crusher house & Wagon Tippler	100	Dust proof / dust tight integral well glass	70 W HPSV/125 W HPMV lamp
11.2	Coal Stack yard/ Open area/ Marshalling yard	10	General purpose flood light & Integral type street Lighting luminaire with aluminium reflector	150 W/250 W/400 W HPSV lamp

* Medium bay fixtures shall be used where the room height is 8 M. Otherwise high bay fixtures are to be used.

Lux level for A.C. Emergency lighting in control room shall be 50 and for other areas 20 lux.

Lux level for main road lighting shall be 20 and for secondary road shall be 10 lux.

Lux level for D.C. Emergency lighting in control room shall be 50 and for other areas 20 lux.

ANNEXURE-E

RATINGS AND REQUIREMENTS OF LIGHTING TRANSFORMER

Type	:	Cast Resin Dry Type
KVA rating	:	100 KVA
Voltage rating	:	415 V/415 V
Cooling	:	AN
P.U. Impedance	:	0.045 ± 10%
Voltage control	:	Off load tap switch/link with change of ± 5% in step of 2.5% tapping full capacity.
Vector Group	:	Dyn11
Class of Insulation	:	F (155°C)
Maximum Temperature rise over 50°C. ambient in winding by resistance	:	90°C
Neutral	:	Solidly grounded.

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

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

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

ANNEXURE-F

FITTINGS AND ACCESSORIES OF LIGHTING TRANSFORMER

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

1. 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm

2. Handling and lifting lugs both for enclosure and core-coil assembly.

3. Jacking pad for core-coil assembly.

4. Inspection cover for cable and box.

5. Door handle operated safety limit switch with 1NO + 1NC contact.

6. Ground bus.

7. IP-55 junction box.

8. Rating and terminal marking plates.

Note

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

VOLUME : IIF/1

SECTION-VII

TECHNICAL SPECIFICATION
FOR
415V PMCC/MCC, 415V ACDB AND 220V DCDB

CONTENTS

VOLUME : IIF/1
SECTION-VII
TECHNICAL SPECIFICATION
FOR
415V PMCC/MCC, 415V ACDB AND 220V DCDB

1.00.00 SCOPE OF SUPPLY

1.01.01 The following equipment shall be furnished complete with all accessories :-

Power cum Motor Control Centre (PMCC)

Motor Control Centre (MCC)

AC Distribution Boards (ACDB)

DC Distribution Boards (DCDB)

1.01.02 The base channel frame with hardware and lifting angles.

1.01.03 One set of special tools and tackles.

1.01.04 Set of accessories as listed below :

a) Breaker lifting and handling trolley

b) Test cabinet with coupling cables for testing the breaker in drawout position

c) Racking in/out handle for breakers

1.01.04 Mandatory Spares.

1.01.05 All relevant drawings, data and instruction manuals

2.00.00 CODES AND STANDARDS

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

2.01.02 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 submitted along with the bid.

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

3.00.00 **DESIGN CRITERIA**

3.01.00 The PMCCs/MCCs/DBs will be used to provide power, control and protection for 415V A.C. auxiliary services (Motors & Feeders) of the generating units.

3.02.00 Duty involves direct-on-line starting of large squirrel cage motors upto 160kW. The starting current varies from 6 to 8 times rated current at very low power factor.

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

3.04.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values stipulated in relevant standards and/or this specification.

3.05.00 All equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of the materials.

3.06.00 The PMCCs shall have two incomers and one bus-coupler. The MCCs / DBs shall have two incomers and one bus-coupler OR two incomers with no bus coupler. In addition to electrical interlocks, mechanical castle key interlock shall be provided between the two incomers and the bus-coupler so that any two of the three may be closed at a time.

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

Busbars of MCC/DBs shall be sized to carry continuously the total running load of MCC/DB plus a 20% margin.

3.08.00 In cubicle of incomers & bus section breakers/MCCBs shall be identical to the associated busbar rating.

3.09.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and/or this specification.

3.10.00 Circuit breakers shall not produce any harmful over voltage during switching off of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.

3.11.00 Incomers, Buscouplers & outgoing feeders rated upto & including 400A shall be MCCB controlled. Above 400A all incomers, Buscouplers & outgoing Feeders shall be ACB controlled.

3.12.00 All motor rated above 110kW, upto & including 160kW shall be ACB controlled. Motor rated upto & including 110kW shall be contactor operated.

3.13.00 MCC & PMCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating and type).

3.14.00 Outgoing feeders of PMCC shall be limited to minimum number of different sizes so that max. standardization is achieved from MCCB & contactor size point of view.

3.15.00 Incomers & bus section breakers of PMCCs shall have provisions for remote operation from control room.

3.16.00 All breaker operated motor feeder shall be supplied from PMCC.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **Construction**

4.01.01 PMCC / MCC / DB shall be indoor, metal-clad, air insulated and floor mounting type. ACB modules of PMCCs/MCCs shall be fully drawout type. MCCB / Switch Fuse modules shall also be fully drawout type. The design and construction shall be such as to allow extension at either end.

4.01.02 Generally PMCC / MCC / DB shall be of double front construction. Circuit Breaker panels of PMCC / MCC / DB shall be of single front construction.

4.01.03 PMCC / MCC / DB enclosure shall be dust and splash proof, conforming to a degree of protection IP-54. Minimum thickness of sheet metal used shall be 2 mm for load bearing members & 1.6 mm for other non-load bearing members.

4.01.04 PMCC / MCC / DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multi tier formation.

4.01.05 The design shall be fully compartmentalized with metal/insulating partitions between compartments. The working height shall be limited within 450 mm to 1800 mm from floor level.

4.01.06 Each control module shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section shall have a removal back cover. All doors and covers shall be gasketed.

4.01.07 All push buttons, lamps, indicating instruments shall be flush / semi-flush mounted on respective module compartment.

4.01.08 A full height vertical cable chamber with cable supports shall be provided in each section to facilitate unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

4.01.09 A horizontal wireway, extending the entire length, shall be provided at the top of each PCC / MCC / DB for inter panel wiring.

4.01.10 The width of the cable alley shall not be less than 250 mm.

4.02.00 **Bus and Bus Taps**

4.02.01 All PMCCs/MCCs/DBs provided with three phase bus bars & neutral Bus bar. All DCDBs shall be provided with two busbars. All busbar compartments shall be completely enclosed.

4.02.02 The main buses and connections shall be of high conductivity Aluminium / Aluminium alloy, sized for specified current ratings with maximum temperature limited to 90°c (i.e., 40°C rise over 50°C ambient) for plain joint and 105°c (i.e., 55°C rise over 50°C ambient) for silver plated joint.

4.02.03 Vertical busbars shall be designed for minimum current rating of 200A. Separate vertical busbars shall be provided for each vertical panel.

4.02.04 All bus connections shall be provided with anti-oxide grease. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.

Bimetallic connector shall be furnished for connection between dissimilar metals.

4.02.05 Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and shrouds for joints and tap-off points shall be provided.

Bus insulators shall be flame retardent, non-hygroscopic track-resistant type with high creepage surface.

4.02.06 Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.

4.02.07 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly.

4.03.00 **Control Modules**

4.03.01 Drawout type control module shall have self-aligning power/control disconnects. All disconnects shall be silver plated to ensure good contacts.

4.03.02 The design shall be such as to permit easy withdrawal/reinsertion of the unit with guide rails to ensure correct alignment.

4.03.03 Control Module shall house the control components for a circuit such as switch fuse / MCCB, contactors, relays, push buttons, lamps etc. as per requirement of the control circuit.

4.03.04 The equipment layout shall provide sufficient working space in between the components.

4.03.05 Various module/compartment sizes shall be multiple of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical bus bars.

4.03.06 Drawout type control modules of same size and type shall be electrically and physically interchangeable.

4.04.00 **Air Circuit Breaker**

4.04.01 Circuit breaker shall be three pole, single throw, air-break type with stored energy, trip-free mechanism and shunt trip.

4.04.02 Circuit breaker shall be draw-out type, having service, test & isolated position with positive indication for each position.

4.04.03 Circuit breakers of identical rating shall be physically and electrically interchangeable.

4.04.04 Circuit breakers shall be provided with motor wound spring charging mechanism. Spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor. In addition, facility for manual charging of spring shall be provided.

4.04.05 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed. It shall not be possible to open the circuit breaker door cubicle unless the breaker is in 'OFF' position.

4.04.06 Automatic safety shutters shall be provided to cover up the stationary disconnects when the breaker is withdrawn.

4.04.07 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indicator, an operation counter and mechanism charge/discharge indicator, and electrical anti-pumping feature.

4.04.08 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose :-

a. Position/Cell switch with 4 NO + 4 NC contacts.

b. Auxiliary switch, with minimum 6NO + 6NC contacts, mounted on the stationary portion of the breaker panel and operated mechanically by a sliding level from the breaker in SERVICE position.

Alternatively, electrically reset latching relay may be used for the purpose. The exact requirement contacts of the position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the Tenderers taking into account the scheme requirements spares. Limit/ auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa

4.04.09 Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches shall be provided with minimum 2NO + 2NC contact.

4.04.10 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.

4.04.11 Each breakers operated feeder shall be provided with protective devices as specified in Annexure–B.

4.05.00 **Switches**

4.05.01 Switches shall be triple/double pole, air break type and designed for duties as specified in Annexure-A. Motor duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.

4.05.02 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

4.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

4.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.

4.05.05 Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.

Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that one of the two can be closed at time.

4.06.00 **Fuses**

4.06.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the short circuit current of the LT system.

4.06.02 Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element.

Visible indication shall be provided on blowing of the fuse.

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

4.07.00 **Moulded Case Circuit Breaker (MCCB)**

4.07.01 The MCCBs shall be of drawout type with trip-free operating mechanism of quick make & quick break type. Each MCCB shall be equipped with thermal release for thermal overload and magnetic release for short circuit protection on each pole.

4.07.02 MCCBs / MPCBs shall be suitable for manual closing and opening and also automatic trip on overload and short circuit. MCCB shall have intermediate position to indicate trip condition.

4.07.03 The MCCBs shall be provided with mechanical ON-OFF indicator at the front panel. The MCCB handles, after the breaker tripped due to faults, shall occupy a mean position indicating trip condition.

4.07.04 The compartment door shall be interlocked mechanically with the MCCB such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for releasing this interlock at any time.

4.07.05 All feeders of PMCC / MCC rated up to & including 400 Amp shall be provided with MCCB. Air circuit breaker shall be provided for feeders rated above 400 Amp.

4.07.06 Motors rating above 110 KW will be operated by Air circuit breaker and protected by consolidated numerical motor protection relay.

4.08.00 **A.C. Starter**

4.08.01 Contactors

a. The contactors shall be three pole, air break type designed for duty class III - Category AC3 (for unidirectional motor) with non-bouncing silver/ silver alloy contacts. Contacts for reversible motors will be of AC4 duty.

b. Each contactor shall be provided with minimum two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V A.C. The exact requirement of contacts shall be decided by the tenderer taking into account the scheme requirements & spares.

c. Reversing contacts shall be electrically and mechanically interlocked.

d. Contactors with delayed dropout feature shall be provided for some essential auxiliaries. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.

4.08.02 Thermal Overload

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

b. Single phase preventor relay shall be provided, as an inbuilt feature of thermal overload relay.

c. Relays shall be manual reset type with two changeover potential-free contacts. Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK.

d. Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.

e. Motor starters shall have type '2' co-ordination according to IEC 947-4.

4.09.00 **D.C. Starters**

4.09.01 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push-buttons, lamps, etc.

4.09.02 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cold rolled continuously annealed (CRCA) fabricated cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2 mm for load bearing members and 1.6mm for other non-load bearing members.

4.09.03 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

4.09.04 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

4.10.00 **Relays**

4.10.01 All incoming and bus-coupler circuits and circuit breaker operated outgoing feeders shall be provided with numerical relays. Breaker operated motor feeders shall be provided with numerical motor protection relay.

4.10.02 The numerical relays shall have provisions for interfacing with Plant DCS / PLC.

4.10.03 Relays shall be of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.

4.10.04 All protective relays, auxiliary relays, and timers shall be provided with hand reset operation indicator (flag).

4.10.05 Relays shall be rated for operation on 110V secondary voltage and 5 A or 1 A. Number and rating of relay contacts shall suit the job requirements.

4.10.06 Make of numerical relays for main protection shall be either Siemens / ABB / Areva.

4.11.00 **Control and Indication**

4.11.01 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

i) One (1) TEST-NORMAL-TRIAL selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

ii) Two (2) push buttons for TRIP and CLOSE

iii) Following indicating lamps on the front of the compartment :

Breaker open - GREEN

Breaker closed - RED

Breaker tripped - AMBER

Spring charged - WHITE

Trip Ckt. Healthy - BLUE

Motor Space heater 'ON' for motor circuit - YELLOW

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

4.11.03 Each push button shall have minimum two (2) nos. normally open and two (2) nos. normally closed contacts rated 10 A at 240 V.

4.11.04 Selectors switches shall be stay-put, rotary type with escutcheon plates marked to indicate the function and positions, and shall be lockable in each position. Selector switch contacts shall be rated for 10A at 240 V A.C.

4.11.05 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.

The exact requirements of contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.

4.11.06 Lamps shall be clustered LED type with series resistor and coloured lens. Lens and lamps shall be replaceable from the front. Lamps shall be located just above the associated push button/control switch

4.11.07 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful Bidder, who shall develop and furnish the schemes accordingly

4.11.07 For control supply, two (2) no. 415/240V control transformers (with ±5% taps @ 2.5%) with 100% standby arrangement and auto transfer scheme shall be provided for each PCC. Control supply healthy indication shall be provided.

4.12.00 **Meters**

4.12.01 All indicating instruments (96 x 96 mm) shall be Digital type, with LED display & flush mounted type and accuracy class of 0.5. Each meter shall have in-built transducer with 4-20 mA output for hooking-up with Plant DCS / PLC.

4.12.02 Motor ammeter shall be suitable to indicate starting current (6 to 8 times full load current) for DOL starting of motor.

Motor ammeter shall be provided for motor rated 30 kW and above and for critical drives, to be finalized during detail engineering.

4.12.03 All incomers, tie feeders and circuit breaker operated motor feeders shall be provided with 3-phase multifunction, digital energy meter with pulse output and communication port for interfacing with Plant DCS / PLC.

4.12.04 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.

4.13.00 **Current Transformer**

4.13.01 Current transformers shall be cast-resin type. All secondary connections shall be bought out to terminal blocks where wye or delta connection will be made.

4.13.02 Accuracy class of the current transformers shall be:

a) Class PS for differential.

b) Class 5P20 for other relaying.

c) Class 1.0 ISF < 5 for metering.

d) Class 0.5 ISF < 5 for metering (Incomer & Bus coupler of PMCC)

Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the tenderers.

4.13.03 CT secondary shall be rated for 1A for metering & either 5A or 1A for protection.

4.14.00 **Voltage Transformer**

4.14.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For Incomer and bus coupler of PMCC accuracy class of voltage transformer shall be 0.5.

4.14.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.

4.14.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.

4.14.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.

4.15.00 **Transducers**

4.15.01 Transducer for conversion of AC electrical quantities such as voltage, current, KW etc. shall be supplied as required for remote connection to Plant DCS / PLC. All transducers shall be dual output type.

4.15.02 The transducers for indicating type instruments shall be of very low burden type having 4-20 mA DC linear, galvanically isolated output, compatible with secondary instruments and Plant DCS system.

4.16.00 **Secondary Wiring**

4.16.01 The PMCC/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.

4.16.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.

4.16.03 Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded Copper conductors of 2.5 mm^2 for control, current and voltage circuits.

4.16.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.

4.16.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals. Separate colour code shall be used for AC & DC circuit wiring for easy identification.

4.17.00 **Terminal Blocks**

4.17.01 Terminal blocks shall be 660V grade box-clamp type with marking strips similar to ELMEX 10 mm^2 or equal. Terminals for C.T. secondary leads shall have provision for shorting.

4.17.02 Terminal blocks used for interface with DCS / PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

4.17.03 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

4.17.04 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.18.00 **Cable Terminations**

4.18.01 PMCC shall be designed for cable entry from bottom. MCC/DB shall be designed for cable entry both from top and bottom. Actual configuration shall be intimated later Sufficient space shall be provided for ease of termination and connection.

4.18.02 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.

4.18.03 Gland plates shall be minimum 4 mm thick. The gland plate and supporting arrangement for 1/C power cables shall be of non-magnetic material to minimize flow of eddy current.

4.18.04 Sufficient space shall be provided between the lower most power cable termination and gland plate for easy cable connection.

4.19.00 **Bus Duct Connection**

4.19.01 Bus duct connections shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.

4.19.02 All connecting bus work shall have the same continuous current rating as associated PMCC bus and shall be fully braced for the LT system short circuit current.

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

4.20.00 **Ground Bus**

4.20.01 A ground bus rated to carry the maximum fault current, shall extend full length of the PMCC / MCC / DB. The ground bus shall be G.I. type of minimum size 50 x 6 mm.

4.20.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.

4.20.03 All stationary structures shall be directly connected to the ground bus for effective grounding.

4.20.04 The frames of all circuit breakers & drawout VT units shall be grounded through heavy multiple contacts at all times except when the primary disconnecting drives are separated by a safe distance.

4.20.05 The frame of draw out module shall be grounded at all times except when the power disconnects are separated by a safe distance.

4.20.06 Where ever the schematic diagrams indicate a definite ground at the switchgear, a single wire for each circuit thus grounded shall be run independently to the ground bus & connected thereto.

CT & VT secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.

4.20.07 All hinged doors shall be earthed through flexible copper braid wire.

4.21.00 **Nameplate**

4.21.01 Nameplate of approved design shall be provided for each control compartment and also at the top of each PMCC / MCC / DB.

4.21.02 The material of the name plate shall be anodized aluminium / lamicoid or approved equal, 3 mm thick, with white letter on black background. Name

plates shall be minimum 20 x 75 mm for instrument / devices and 40 x 150 mm for panels.

4.21.03 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

4.22.00 **Space Heater**

4.22.01 Each vertical section of the PCC / MCC / DB shall be furnished with thermostat controlled space heater and 5A, 3 pin plug socket.

4.22.02 In addition, motor feeders 30 KW and above shall be wired up for feeding motor space heater through starter auxiliary NC contacts.

4.22.03 Cubicle heater, Motor heater and plug socket circuit shall be provided with individual MCB/switch fuse units.

4.23.00 **A.C./D.C. Power Supplies**

4.23.01 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C. supply and duplicate feeder shall be arranged for D.C. supply.

4.23.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.

4.23.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.

4.23.04 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

4.24.00 **Tropical Protection**

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

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

4.25.00 **Painting**

4.25.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

4.25.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

4.25.03 PCC / MCC / DB shall be finished in light grey (RAL 7032) with two coats of synthetic enamel paint.

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

4.25.05 Caution notice plate shall be affixed at the back of each vertical panel.

5.00.00 **TESTS**

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

5.02.00 **Routine Test**

The tests shall include but not necessarily be limited to the following :-

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b. All wiring and current carrying part shall be given appropriate High Voltage Test.

c. Primary current & voltages shall be applied to all instrument transformers.

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

5.03.00 **Type Tests**

The type test certificates for the following tests carried out on an identical & similar type of switchgear shall be furnished. The date of tests shall be within the last five years.

a. Temperature rise Test

b. Short time current test on main circuit and earth circuit.

c. Verification of making and breaking capacity.

Type test certificates of any equipment shall be furnished if so designed by the purchaser/ owner. Otherwise the equipment shall have to be type tested free of charge, to prove the design. Type test performed before five(5) years are not acceptable.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 To be submitted with the bid :-

a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.

b. Typical foundation plan

c. Typical control schematic

d. Bill of materials

e. Type test reports on circuit breaker

f. Board wise single line diagram.

g. Calculation of CT & VT rating.

h. Busbar sizing calculation.

i. Reports for all type tests of representative sections of panel assemblies.

j. Technical leaflets on :-

i) Circuit breaker
ii) Contactors
iii) Relays, meters, push buttons, selector switches etc.
iv) Glands/terminals blocks
v) MCCB
vi) MCB
vii) Instrument Transformers

6.02.00 To be submitted for Approval & Distribution :

a. Outline dimensional drawing showing general arrangement, space requirements and bus duct/cable entry points.

b. Boar wise Single Line Diagrams.

c. Cross-section with parts list.

d. Foundation plan & loading.

e Consolidated bill of materials

f. Control schematics.

g. Wiring Diagrams.

h. Instruction manuals of PMCC/MCC/DB and individual equipment.

i. All other relevant drawings, documents or data necessary for satisfactory installation, operation and maintenance.

The manuals shall clearly indicate that the installation method, check-up and tests to be carried out before commissioning of the equipment.

6.03.00 The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.

ANNEXURE-A

RATINGS AND REQUIREMENTS

1.0	General			
	Type	:	ACB Modules - Drawout type MCCB Modules – Drawout type	
	Service	:	Indoor	
	Enclosure	:	IP54	
2.0	System		AC	DC
	Voltage	:	415V ± 10%	220V (190-240V)
	Phase	:	3-phase, 4-wire	2- wire
	Frequency	:	50 Hz ± 5%	-
	Combined voltage and Frequency variation	:	10% (absolute sum)	
	System grounding	:	Solidly grounded	Ungrounded
3.0	Rating			
	Rated current	:	To be decided by the tenderers.	
	Design Ambient Temperature	:	50ºC	
	Short Circuit Current Symm.	:	50 KA	25* KA
	* Indicative only, the actual value will be decided by the tenderers.			
	S/C Withstand Time	:	1 second	
	Hi pot for 1 minute	:	2.5 kV	1.5 kV
4.0	Duty			
	Circuit Breaker	:	0-3'-CO-3'-0	
	Contactor (AC)	:	Class III - Category AC3 for unidirectional drives and AC4 for bi-directional / inching duty drives	
	Contactor (DC)	:	Class 1 – category DC2	
	MCCB / Switch Duty for		AC	DC
	Motor Feeder	:	AC23	DC22

Other Feeder	:	AC22	DC22

5.0 A.C. / D.C. Power Supply

Control Voltage for Circuit breaker	:	220V DC +10% to -15%
Control voltage for MCCB modules	:	240V AC ± 10%, 1 Ph, 50 Hz ± 5%
Service voltage	:	240V AC ± 10%, 1 Ph, 50 Hz ± 5%

ANNEXURE-B

PROTECTIONS

1.0 All Protective relays shall be microprocessor based numerical type having communication facility with Plant DCS system / PLC.

2.0 The minimum protections to be provided for different types of circuits are listed below:

a.	Incoming Feeder & Bus-coupler with ACB:	3	-	inverse time O/C relays (51) for phase fault.
		1	-	Inverse time O/C relay (51N) for Earth fault.
		3	-	Under Voltage (27), Range : 40-80% with timer
b.	Motor Feeder with ACB: (above 110 kW)	1	-	Composite Motor protection relay (99) for protection against
			-	Thermal overload
			-	Phase faults
			-	Unbalance (negative sequence)
			-	Locked rotor
			-	Excessive Start-up time and Start-Stop.
			-	Earth fault
c.	Outgoing Feeder with ACB :	3	-	Inverse time O/C relays (51) for phase fault.
		1	-	Inverse time O/C relay (51N) for Earth fault.

2.0 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type.

3.0 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided..

4.0 For Auto-bus change-over as well as live bus change-over through synchronization refer enclosed Control Schematic drawings.

5.0 Each incomer shall be provided with three (3) nos. Bus Energised indicating lamps – Red/Yellow/Blue for each phase.

ANNEXURE-C

INDICATIVE LIST OF 415V PMCCs / MCCs / DBs

A.	PMCC/MCC		Quantities
1)	415 V Unit PMCC	:	1 no.
2)	415 V Station PMCC	:	2 nos.
3)	415 V Emer. PMCC	:	1 no.
4)	415 V ESP PMCC	:	6 nos.
5)	415 V Turbine Valve MCC	:	1 no.
6)	415 V Turbine Aux. MCC	:	1 no.
7)	415 V Coal Mill MCC	:	1 no.
8)	415 V Boiler Valve MCC	:	1 no.
9)	415 V Boiler Aux. MCC	:	1 no.
10)	415 V Soot Blower MCC	:	1 no.
11)	415 V CPU REGN. MCC	:	1 no.
12)	415 V STN Vent. MCC	:	1 no.
13)	415 V ESP Vent & A/C MCC	:	1 no.
14)	415 V Fuel Oil Unloading & Transfer P/H MCC	:	1 no.
15)	415 V Fire Water MCC	:	1 no.
16)	415 V Bunker Floor MCC	:	1 no.
17)	415 V Wagon Tripler PMCC	:	1 no.
18)	415 V CHP PMCC	:	1 no.
19)	415V ASH Silo PMCC	:	1 no.
20)	415V Raw Water PMCC	:	1 no.
21)	415 V Station AC MCC	:	1 no.
22)	415V CW Treatment PMCC	:	1 no.
23)	415V CW Chlorination MCC	:	1 no.
24)	415 V CWPH PMCC	:	1 no.

25)	415V Clarified Water MCC	:	1 no.
26)	415 V Water Treatment PMCC	:	1 no.
27)	415 V Switchyard PMCC	:	1 no.
28)	415V Fuel Oil Pressurizing MCC	:	1 no.
29)	415V Ash Water Recovery MCC	:	1 no.
30)	415V AHP PMCC	:	1 no.
31)	415V Ash Slurry MCC	:	1 no.
32)	415V AHP Water System MCC	:	1 no.
33)	415 V Ash Dyke MCC	:	1 no.
34)	415V DM PLANT MCC	:	1 no.
35)	415V Water Service PMCC	:	1 no.
36)	415V ETP PMCC	:	2 nos.
37)	415V Station AC MCC	:	1no.

B.	415V ACDBs		Quantities
1)	Station ACDB	:	To be decided by EPC contractor
2)	Boiler ACDB	:	To be decided by EPC contractor
3)	Turbine ACDB	:	To be decided by EPC contractor
4)	Lighting Distribution Board	:	To be decided by EPC contractor
5)	Welding Transformer Board	:	To be decided by EPC contractor
C.	240V ACDBs	:	AS Required (To be decided by EPC contractor)
D.	220V DCDBs	:	AS Required (To be decided by EPC contractor)

NOTE : Any other PMCCs / MCCs / DBs, if required, shall also be included under the Scope of EPC Contractor without any price implication.

ANNEXURE-D

MODULE SELECTION

MOTOR FEEDER

Type	Motor Rating	MCCB Rating	Contactor	Cable size
AU/AR	0 - 5.5 KW	32A	16A	3/c – 2.5 Sq.mm - Cu
BU/BR	5.6 - 11 KW	63A	32A	3/c - 16 Sq.mm - Al
CU	11.1 - 22 KW	63A	63A	3/c - 35 Sq.mm - Al
DU	22.1 - 50 KW	100A	100A	3/c - 95 Sq.mm - Al
EU	50.1 - 75 KW	200A	160A	3/c - 185 Sq.mm - Al
FU	75.1 - 110 KW	400A	300A	2 x 3/c - 185 Sq.mm - Al

NOTE :

1. MCCB, thermal overload relay with SPP, Contractor are to be co-ordinated (Type-2) with motor rating by the Contractor.

2. “U” stands for Undirectional and “R” for Reversible drives.

OUTGOING FEEDER

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

DCDB FEEDER (SFU Unit)

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

NOTE : Cable size as shown above are indicative only. However actual sizes of each motor/ outgoing feeder to be decided by the EPC contractor with back up sizing calculation.

ANNEXURE-E

BUS TRANSFER SCHEME FOR PMCC

1.0 The manual bus transfer shall be arranged in such a way that any of the following modes of operation is possible.

1.1 **Manual Bus Transfer**

a) Without voltage interruption

This means by allowing momentary parallel operation of two sources.

b) With voltage interruption

i) Slow Transfer

ii) Fast Transfer

NOTE : For CHP system 'Manual bus transfer without voltage interruption' and 'dead bus transfer with voltage interruption' shall be provided.

Synchronisation of Incomer & Bus coupler for each of the 415V PMCC shall be implemented through PLC in CHP substation cum control room building (SS-2). Synchronization check relay, guard relay and auxiliary relay shall be provided in each PMCC. Synchroscope along with cut off switch, double voltmeter, double frequency meter shall be provided in the Main CHP substation building cum control room. Separate synchronization switch and trip selector switch for each of the PMCC shall also be provided in the CHP substation building cum control room (SS-2).

VOLUME : IIF/1

SECTION-VIII

TECHNICAL SPECIFICATION FOR LOCAL CONTROL BOARDS/PANELS, LOCAL ISOLATING SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS

CONTENT

VOLUME : IIF/1

SECTION-VIII

TECHNICAL SPECIFICATION FOR LOCAL CONTROL BOARDS/PANELS, LOCAL ISOLATING SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS

1.00.00 SCOPE OF SUPPLY

1.01.00 The following equipment shall be furnished with all accessories:

a) Complete set of Local Control Boards/Panels, an indicative list of which is given in Annexure-C

b) Local Push Button Stations: As required

c) Local Isolating Switch Units: As required

1.02.00 Furnishing, Mounting, and wiring of all equipments, devices and accessories

1.03.00 Floor Channel sill, vibration damping pad, and kick plates for all floor-mounted control boards/panels, complete with holding down bolts and nuts.

1.04.00 Mounting hardware for all control boards/panels, Local Push Button Stations, and Local Isolating Switch Units.

2.00.00 CODES AND STANDARDS

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

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

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

3.00.00 DESIGN CRITERIA

3.01.00 The Local Control Boards/Panels will be used for controlling incomers/ bus-section/electrically operated radial breaker feeders of the associated PMCC/MCC. Necessary indications, meters, annunciations and mimic representation shall also be provided on these control boards/panels.

Local control of all drives shall be done from Process Control Boards/Panels, as described in respective sections of mechanical specification.

The Local Control Boards/Panels shall have to be duly matched with the Process Control Boards/Panels.

3.02.00 Local Push Button (L.P.B.) stations will be used for controlling drives from local as required.

3.03.00 Local Isolating Switch (L.I.S) Units will be used for local isolation of power supply to various machines as required.

3.04.00 All equipment except L.I.S. Units and L.P.B stations, will be located in a clean but hot, humid, and tropical atmosphere. The L.I.S. Units and L.P.B. stations will be generally installed in a hot, humid, and tropical atmosphere, heavily polluted at places with fly ash and/or coal dust, and shall be suitable for outdoor service with degree of protection specified elsewhere in this specification.

3.05.00 All Control Boards/Panels, L.I.S. Units, and L.P.B. stations shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

3.06.00 Adequate space/terminals shall be kept in the boards/panels for installing additional equipment in future.

3.07.00 For continuous operation at specified ratings, temperature rise of the various components/equipment shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

3.08.00 All equipment/components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the system short circuit current without any damage or deterioration of material.

3.09.00 Design, material selection, and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws, or bolt heads apparent from the exterior surface of the boards/panels. All instrument cut-outs, mounting studs, and support brackets shall be accurately located.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Construction

4.01.01 Local Control Boards/Panels

a) Local Control Boards may consist of a number of vertical panels mounted side-by-side, in which case, they shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close-fitting, and unobtrusive.

b) The control boards/panels shall be totally enclosed type, conforming to degree of protection IP-54 or better.

c) Generally, the local control boards/panels shall be free-standing, floor-mounted, dead-front assemblies. In some cases, however, wall-mounted type control boards/panels may also be accepted.

d) Floor-mounted control boards/panels shall be assembled on channel/ angle base plates with anti-vibration mountings and stainless steel kick-plates.

e) Control boards/panels shall be of folded sheet steel CRCA construction, minimum 1.6 mm. thick for non-load bearing members and 2 mm for load bearing members, and free from all surface defects.

The boards/panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.

f) All floor-mounted panels shall have rear door.

g) Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.

h) All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.

i) Working height of the panels shall be limited between 550 mm and 1800 mm above floor level.

4.01.02 Local Push Button Stations

a) L.P.B. Stations shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketted construction, suitable for outdoor use with or without canopy according to outdoor / indoor installation, and conforming to degree of protection IP-55 or better.

b) L.P.B. Stations shall be suitable for column/structure/wall mounting and shall be complete with push-buttons, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing terminals, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing terminals shall be suitable for connection to one (1) no. 8 SWG G.I. wire.

c) L.P.B. Stations shall be of the following basic type and equipped with:

Type-A	:	One (1) START push-button and one (1) STOP push-button.
Type-B	:	One (1) OPEN push-button, one(1) CLOSE push-button, and one(1) STOP push-button.
Type-C	:	Flame proof type as per IS-2148. one (1) START push-button and one(1) STOP push-button.
Type-D	:	One (1) STOP Lock-out switch.

Type-E : One (1) STOP Emergency PB.

Belt sway bridging Push Button shall be provided in the Local Push Button Station for all conveyor Drives.

Any other type of L.P.B. Station, if required, shall be subject to approval of the Purchaser.

d) OPEN, CLOSE, and START push-buttons shall be spring return to normal type. STOP push-buttons shall have mushroom head actuator with press-to-latch and key-to-release feature.

e) OPEN/START push buttons shall be GREEN, STOP push buttons shall be RED, and CLOSE buttons may be YELLOW.

f) All push-buttons shall have a minimum of two (2) Normally-Open and two (2) Normally-Closed electrically separate contacts, rated minimum 10 A at operating voltage.

g) Wiring shall be done by 1/C - 2.5 sq.mm. 1100V grade, PVC insulated, stranded copper conductor, cable. Each wire shall be identified at both ends by ferrules with wire designation.

h) Terminals shall have provision for connecting at least two (2) nos. 2.5 sq.mm. copper cable and shall be rated for carrying continuously minimum 10 A at 240V A.C. and 2 A at 220V D.C.

4.01.03 Local Isolating Switch Units

a) L.I.S. Units shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketted construction, suitable for outdoor use with / without canopy according to outdoor/indoor installation, and conforming to degree of protection IP-55 or better.

b) L.I.S. Units shall be suitable for column/structure/wall mounting and shall be complete with load-break switch, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing pads, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing pads shall be suitable for connection to 25 x 3 mm G.S. flat

c) Load-break switches shall be four-pole, air break, heavy-duty type. Duty class of load-break switches shall be AC-23 for motor feeders. Motor feeder switches shall be capable of safely breaking the locked rotor current of the associated motor circuit.

d) Terminals shall be clip-on type, 10 sq.mm. minimum.

4.02.00 **Equipment Mounting**

4.02.01 All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of services to others. No equipment shall be mounted on panel door.

4.02.02 All equipment mounted inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

4.02.03 For Local Control Boards/Panels control components such as push buttons, indicating lamps, selector switches, indicating meters etc. shall be flush mounted on the front face of the board/panel while switch fuses, supervision relays (AC/DC) etc. shall be mounted inside.

4.03.00 **Name Plate**

4.03.01 Nameplates shall be furnished for each panel and for each instrument or device mounted on the panel. Each LPB Station shall also be provided with a nameplate.

4.03.02 The material of the nameplate shall be lamicoid or approved equal, 3 mm thick, with white letters on black background.

4.03.03 The nameplates shall be held by self tapping screws. The size of nameplate shall be approx. 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels. The size of the nameplate shall suit the overall dimensions of LPB station/L.I.S Unit.

4.03.04 Nameplates for panels shall be provided both on the front and on the rear and shall be according to final device/designation list.

4.03.05 Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.

4.03.06 Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument or device number. The number may be painted on or adjacent to the instrument or device case.

4.04.00 **Mimic Diagram**

4.04.01 Mimic diagram of electrical connections shall be furnished on the front face of all electrical control panels.

4.04.02 Mimic buses shall be at least 3 mm thick and 10 mm in width, made of suitably treated metal strips or approved equivalent and colour coded to denote different voltages.

4.04.03 The mimic representation, colour and size of diagram are subject to the approval of the Purchaser.

4.05.00 **Illumination, Space Heating and Receptacles**

4.05.01 Each panel shall be provided with interior fluorescent tube with door switch, space heater with thermostat and 5A, 3-pin receptacle with plug. Third pin of the socket shall be effectively grounded through the metallic structure.

4.05.02 Tube, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

4.05.03 The lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

4.06.00 **AC/DC Power Supply**

4.06.01 Necessary A.C. and D.C. supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C supply and duplicate feeders shall be arranged for D.C supply.

4.06.02 Isolating switch fuse units shall be provided for the incoming AC/DC power supplies and bus wires shall be run for power distribution to different panels. D.C. supply isolating switches shall be double pole, double throw with off and A.C. supply isolating switches shall be 4-pole, double throw type.

4.06.03 Fuse and link shall be provided for individual circuits for protection and also for isolation from bus wire without disturbing other circuits.

4.06.04 The fuse requirements in each panel shall be grouped in easily accessible fuse blocks or distribution panel. The grouping shall be done in a neat and orderly fashion.

4.06.05 Alarm relays with reverse flag shall be provided to annunciate failure of main incoming A.C. and D.C. power supplies and annunciation D.C. supply in each panel. Lamp indications shall be provided individually for main D.C. supply-1 fail, main D.C. supply-2 fail, and panel annunciation D.C. supply fail. A common A.C. electric bell shall be provided to give an audible alarm in case of failure of D.C. supply-1/D.C. supply-2/annunciation D.C. supply in any panel. A common push-button shall also be provided for cancellation of lamp indications and audible alarm.

4.06.06 Separate circuits shall be provided for (a) indication and alarm (b) tripping, and (c) control.

4.06.07 For lighting, auxiliary supply and space heating A.C. supply shall be used. D.C. supply shall be used for providing control supply to annunciator.

4.06.08 Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles of a VDB. Isolating switch fuse units shall be provided at each cubicle for A.C/D.C supplies.

4.07.00 **Wiring**

4.07.01 The panels shall be fully wired up at the factory to ensure proper functioning of control, protection and metering schemes.

4.07.02 All spare contacts of relays and switches shall be wired up to terminal blocks.

4.07.03 Wiring shall be done with flexible, heat resistant, 1100V grade, fire resistance PVC insulated, switchboard wires with stranded copper conductor, 2.5 Sq.mm for current, control circuits and voltage circuits.

4.07.04 Each wire shall be ferruled by plastic tube with indelliable ink print at both end having terminal Block No., terminal numbers, destination number as per approved wiring drawing.

4.07.05 All wire termination shall be made with insulated sleeve solderless crimping type tinned copper lugs. Wires shall not be tapped or spliced between terminals.

4.07.06 Wiring shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on the termination.

4.07.07 Colour codes shall be used for wiring as per latest revision of IS: 375.

4.08.00 **Terminal Block**

4.08.01 Multi-way terminal blocks complete with necessary binding screws and washers for wire connections and marking strip for circuit identification shall be furnished for terminating the panel wiring and outgoing cables. Terminals shall be box-clamp type, 10 sq.mm. minimum. Terminals for C.T. secondary leads shall have provision of shorting and grounding.

4.08.02 Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.

4.08.03 Each terminal shall be identified with designation as per approved schematic. At least 20% of the total number of active terminals shall be furnished as spare in each panel.

4.08.04 The wiring and terminals shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.08.05 The terminal blocks shall be located to allow easy access and also to suit floor openings for cable entry.

4.08.06 The terminal blocks within the panels shall be mounted on vertical support brackets. The support brackets shall be tack welded to the interior sheet steel mounting plates of the cabinet. Support brackets shall not be welded directly to the walls of the enclosure. The terminal blocks shall be attached to the support brackets with round head machine screws.

4.08.07 Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100 mm) between adjacent rows.

4.08.08 The bottom of the terminal block shall be at least 200 mm above the incoming cable gland plate.

4.09.00 **Cable Entry**

4.09.01 The Control Boards/Panels shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight. L.P.B. stations and Local Isolating Switch Units shall have provision for cable/ conduit entry from both top and bottom. Suitable cable gland-plates shall be provided.

4.10.00 **Grounding**

4.10.01 50 x 6 mm TINNED COPPER ground bus shall be provided in each control panel extending along the entire length of the assembly.

4.10.02 The ground bus shall have two-bolt drilling with GI bolts and nuts at each end and shall be suitable for connection to 50 x 6 mm G.S. flat.

4.10.03 The ground bus shall be bolted to the panel structures and shall effectively ground the entire assembly. The cases of meters, relays and switching devices shall be grounded through the steel structure.

4.10.04 Whenever a circuit is grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.

4.11.00 **Painting**

4.11.01 Panels and Push-button Stations shall be finished with two coats of synthetic enamel paint white inside and gray (shade 631 of IS-5) outside. Panels and push-button stations shall be stoved after each spraying of finish paint. Painting process shall be of powder coating.

4.11.02 Caution Notice plate shall be affixed at the back of each vertical panel.

4.12.00 **Switches**

4.12.01 Switches shall be dust protected, heavy duty, switchboard type, complete with escutcheon plate. Contacts shall be silver surfaced and rated minimum 10A at operating voltage.

4.12.02 415V Breaker control switches shall be 3-position (TRIP/NORMAL/-CLOSE), 120^{o}, spring return to neutral with lost motion device, non-lockable, sequence device, pistol grip handle, RED/AMBER/GREEN (circuit breaker CLOSED/ TRIPPED-OR-TRIP CIRCUIT UNHEALTHY/OPEN) indicating lamps shall be provided with each breaker control switch.

4.12.03 Contact details and type of handle required for other types of switches are given below :

Sl. No.	Application	Switch description
a)	Synchronising Selector switch	180^{o}, 4-position (INCOMER-1/ BUS-SECTION / INCOMER-2/OFF), stay put type, pistol grip handle. OR 120^{o}, 3-position (INCOMER/TIE/ OFF) stayput type, pistol grip handle.
b)	Trip Selector Switch	120^{o}, 3-position (INCOMER-1/ BUS-SECTION OR TIE/ INCOMER-2), stayput type, pistol grip handle.

Sl. No.	Application	Switch description
c)	Meter Selector Switch	4-position (OFF/R/Y/B for ammeter selector switch and OFF/RY/YB/RB for voltmeter selector switch), maintained

		contact, stay-put type, knob handle. Ammeter selector switches shall have make-before- break contacts.
d)	Auto-Manual Selector switch	120°, 2-position (AUTO/ MANUAL), stayput type, non-lockable, spade handle.
e)	On-off Switch/Local-Remote Selector Switch	90°, 2-position (ON/OF OR LOCAL/ REMOTE), stayput type, non-lockable, spade handle

4.12.04 Any other type of switch, if required, shall be subjected to approval of purchaser.

4.12.05 Tenderer shall decide the number of switch contacts taking into account the scheme requirements and spares.

4.13.00 **Fuses**

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

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

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

4.14.00 **Contactors**

4.14.01 Contactors shall be three pole, air break type, with non-bouncing silver/silver alloy contacts. Contactor duty shall be class III - category AC3 for unidirectional drives and AC4 for bi-directional and inching drives/class I - category DC2.

4.14.02 Each contactor shall be provided with minimum two (2) N/O and two (2) N/C auxiliary contacts rated 10 A at operating voltage. The exact requirement of contacts shall be decided by the Tenderers taking into account the scheme requirements and spares.

4.14.03 Contactor starters shall comply with the requirements of IS-8544 (Part - 1) in respect of co-ordination of the characteristics of contactor, overload relay, and fuse. The type of co-ordination shall be Type-C as per IS-8544.

4.15.00 **Thermal Overload**

4.15.01 Thermal overload relays shall be three elements, positive acting, ambient temperature compensated with adjustable settings.

4.15.02 Single phasing preventor shall be provided as an inbuilt feature of the thermal overload relay.

4.15.03 Overload relays shall be manual reset type with change over contacts. Resetting of relays shall be possible with compartment door closed. Colour of resetting button shall be BLACK.

4.15.04 Relays for fan motors having long starting time shall be saturable core C.T. operated.

4.16.00 **Current Transformers**

4.16.01 Current transformers shall be cast-resin type. All secondary connections shall be bought out to terminal blocks where wye or delta connection will be made.

4.16.02 Accuracy class of the current transformers shall be:

a) Class PS for differential.

b) Class 5P20 for other relaying.

c) Class 1.0 ISF < 5 for metering.

Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the tenderers.

4.16.03 Drives requiring current monitoring shall be provided with current transducers with calibration for full-scale reading. The output shall be 4-20 mA D.C; 4-18mA of which shall correspond to the normal range and 18-20 mA shall correspond to the suppressed range.

4.17.00 **Voltage Transformers**

4.17.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0.

4.17.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.

4.17.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.

4.17.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.

4.18.00 **Push Button**

4.18.01 All push buttons shall be oil tight, heavy duty, push to actuate type, with coloured button and inscription plate marked with its function. The colour of "ON" and "OFF" push buttons shall be GREEN and RED respectively. RESET push buttons shall be coloured black.

4.18.02 Each push button shall have minimum 2 NO. + 2 NO. contacts, rated 10A at 240V AC and 2A at 220V DC.

4.18.03 Push buttons shall be shrouded type except for emergency trip/stop button, which shall be mushroom type with lockable arrangement for easy identification.

4.19.00 **Lamps**

4.19.01 All indicating Lamps shall be LED type.

4.19.02 LED lamp shall be made in accordance with InP Technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamp shall be as per LED indicating lamp.

4.20.00 **Operating Range**

All instruments shall be generally suitable for operation on 1A or 5A C.T. secondary circuit and/or 110V V.T. secondary circuit.

4.21.00 **Meters**

4.21.01 All indicating instruments shall be switchboard type, back connected, suitable for flush mounting, 96 x 96 mm with 240 Deg. scale, antiglare glass and accuracy class of 0.5. The dials shall be made of such material as to ensure freedom from warping, fading, and discolouring during the lifetime of the instruments.

4.21.02 All indicating instruments shall be enclosed in dust-tight cases suitable for tropical use.

4.21.03 Meters shall have provision for zero-adjustment from front of the panel.

4.21.04 Meters shall be compensated for temperature errors and factory calibrated to read the primary quantities directly without using a multiplying factor.

4.21.05 D.C. ammeters, wherever required, shall be provided with external shunt if the current exceeds 5A. The rated voltage drop for the shunts shall be 75mV.

4.22.00 **Annunciator System**

4.22.01 Each control panel shall be provided with an annunciator window board. The annunciator boards shall be back-connected and suitable for semi-flush mounting.

4.22.02 The annunciator system shall be solid state type with optical isolation for input signals. The functional requirements shall be as per Annexure-C.

4.22.03 Each annunciator group shall be independent, complete with its own power supply, acknowledge-reset-test buttons and other necessary accessories. Hooter for audible alarm shall be common for each control panel assembly.

4.22.04 Each annunciator group shall be provided with a common alarm relay for group alarm annunciation in remote control room. The common alarm relay will operate on actuation of any alarm point of the group.

4.22.05 The annunciator shall be non-integral type with hardware box mounted separately for easy access and maintenance.

4.22.06 Audible alarms with different tones shall be used for trip, non-trip and ring back functions.

4.22.07 The window size shall be such as to accommodate minimum three (3) lines of twelve (12) characters each. Each character shall be minimum 4.75 mm high.

4.22.08 The annunciator system shall be suitable for operation from both NO and NC type initiating contacts.

4.22.09 At least 10% spare channels and window facia shall be provided in each annunciator group.

4.23.00 **Relays**

4.23.01 Auxiliary relays shall be furnished in fixed, dust-tight, casings and mounted inside the panel.

4.23.02 The relays shall have adequate numbers of contacts to suit scheme requirements. Besides, each relay shall have spare contacts for future use.

4.23.03 Contacts shall be silver-surfaced, bounce-free, and capable of repeated operation without deterioration.

4.24.00 **Auxiliary Devices**

4.24.01 The Contractor shall furnish, install, and wire-up all auxiliary devices such as timing / switching / lockout / auxiliary relays/auxiliary contactors, etc. as required for the proper functioning of the approved schemes.

4.24.02 The Contractor shall number the various types of relays and contactors as per the numbers appearing in the approved Schematic/Wiring appearing in the approved Schematic/Wiring diagrams.

5.00.00 **TESTS**

5.01.00 All Control Boards/Panels, L.I.S. Units and L.P.B. Stations shall be completely assembled, wired, adjusted and tested at the factory prior to shipment to ensure accuracy of wiring, correctness of control scheme and proper functioning of all components.

5.02.00 **Routine Tests**

5.02.01 The tests shall include wiring continuity tests, high voltage tests, insulation measurement test both before and after high voltage test, and functional tests to ensure accuracy of wiring operation of the control/ protection/metering schemes and individual equipment. Detailed test report including procedure and drawing shall be furnished.

5.02.02 All switches, meters, relays and other devices shall be tested and calibrated in accordance with relevant IS standards.

5.03.00 Type test certificate on any equipment, if so desired shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 **To be submitted with the Bid**

6.01.01 General Arrangement drawings and cross-section of each equipment showing constructional features, cable entry points etc.

6.01.02 Typical foundation plan.

6.01.03 Bill of Materials.

6.01.04 Technical leaflet and Catalogues of:

a) Local Control Boards and Local Starter-cum-Control panels

b) Local Isolating switch units

c) Local Push Button Stations

d) Switches and Lamps

e) Meters, relays, push buttons

f) Switch fuse units

g) Annunciator System

h) Auxiliary Devices

i) Terminal Blocks/glands.

j) Temperature Scanner

6.02.00 **To be submitted after award of Contract**

6.02.01 Dimensional general arrangement of all Local Control Boards, Local Starter-cum-control panels, Local Push Button Stations, and Local Isolating switch units showing equipment disposition and identification along with space requirements and cable entry points.

6.02.02 Foundation plan and loading diagram, clearly showing panel fixing arrangement, floor opening for cable entry etc

6.02.03 Cross section with parts list

6.02.04 Schedule of materials and label inscriptions.

6.02.05 Detailed Control Schematics clearly showing terminal and wire numbering

6.02.06 Wiring diagram showing all equipment and devices in their relative physical positions and all wiring upto the terminal blocks.

Equipment/Device and terminals shall be identified with designations/numbers as per approved schematic and connection diagrams.

6.02.07 Data Sheets and Instruction Manual for each piece of equipment

6.03.00 Tenderers may note that the drawings, data and manuals listed are minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.

ANNEXURE-A

RATINGS & REQUIREMENTS

1.0	Local Control Board		
1.1	General		
	Type	:	Fixed type
	Service	:	Indoor
	Enclosure	:	IP-54
1.2	System		
	Voltage	:	415 Volt ± 10%
	Phase	:	3
	Frequency	:	50 Hz ± 5%
	System	:	Solidly grounded
1.3	Rated Current at 50°C		
	Bus bar	:	To be decided by the Tenderers
	Switches	:	To be decided by the Tenderers
1.4	Short Circuit Rating		
	Interrupting	:	50 KA
	Short time for 1 Second	:	50 KA
1.5	Insulation Level	:	2.5 KV for 1 min.

ANNEXURE-B

FUNCTIONAL REQUIREMENTS OF ANNUNCIATOR

TYPE

The annunciation system shall be manually reset type with ring back facility, suitable for operation from 220V DC ungrounded supply.

FUNCTION

The sequence of operation shall be similar to ISA-2A with fast/slow blinking as detailed below:

Field Condition	Visual Display	Audible Alarm	Ringback Alarm
Normal	Off	Silent	Silent
Abnormal	Fast blinking	On	Silent
Acknowledge	Steady On	Silent	Silent
Return to normal	Slow blinking	Silent	On
Reset	Off	Silent	Silent
Normal Before Acknowledge	Slow blinking	On	On
Acknowledge	Steady On	Silent	On
Reset	Off	Silent	Silent
Test	Fast blinking	On	On

ANNEXURE-C

AREA WISE INDICATIVE LIST OF LOCAL CONTROL BOARDS

Sl. No.	Description
1.	C.W. System Electrical Control Board
2.	Electrical Control Board for MCC/PMCC located in Ash-Slurry and Ash-Water Building.
3.	Electrical Control Boards for ESP PCC/PMCC
4.	Electrical Control Board for Fuel Oil Pressurising system
5.	Electrical Control Board for Fuel Oil Unloading and Forwarding MCC
6.	Electrical Control Boards for Raw water MCC

Note : The above list is indicative only. In addition to the above Electrical Control Boards, necessary local panels/remote panel shall be provided for respective system/equipment/drive, e.g., BFP, Hydrogen-seal Oil system for Generator, ESP, etc. as described in respective sections of mechanical specification.

ANNEXURE-D

LOCAL CONTROL PANEL / LOCAL STARTER PANEL FOR COAL HANDLING PLANT

1.00.00 DESIGN CRITERIA

1.01.00 Stacker/Reclaimer MCC & Control Desk

The power supply from 6.6 KV CHP switchgear shall be achieved through one (1) number land mounted load break isolator, one (1) number fuse cum junction box located near centre or travel, one (1) number machine mounted load break isolator, line P.T with voltmeter on 6.6 KV side, L.T Air Circuit Breaker, Ammeter with selector switch, Voltmeter with selector switch etc.

Power CRD shall be connected to isolator panel mounted on the machine. H.T. fuses for the primary side of the transformer shall be housed inside the isolator panel on machine. Fuses shall be provided with the striker pin mechanism.Specification of Load break isolator is governed by HT Switchgear Specification

1.01.01

a) One number Stacker-Reclaimer MCC shall be provided on the mobile Stacker-Reclaimer. This MCC shall receive power at 433V, 50 Hz, from the output of a 6.6 KV/433V, dry type cast resin power transformer located on the mobile machine, through suitable cables.

b) Power shall be received at the panel by means of ACB unit. The ACB shall be series trip type with short circuit and ground fault releases having adjustable settings. Necessary CT ammeter, ammeter selector switch; voltmeter; voltmeter selector switch; R/Y/B indication lamps shall be available on the MCC. Power supply for indication of breaker including load break isolator shall be derived from the UPS of PLC. The specification requirement of MCC is guided by respective 415V PMCC/MCC specification.

c) Stacker/Reclaimer is PLC controlled. Under manual local operation it shall only be possible to run individual equipment by passing all process interlock. Under manual remote operation it shall be possible to run the entire system through PLC with process and safety interlock in place. The selector switch, remote/local shall be housed in control desk.

d) Specification requirement of PLC has been detailed under main PLC specification with the exception of 100% hot standby mode and redundancy.

e) Control desk shall accommodate annunciation windows, selector switches, ammeter, voltmeter and indicating lamps for incomer, ammeter for outgoing motor feeder rated 30 KW and above.

f) Panel door shall be interlocked with the incoming switch such that the panel door can not be opened when the switch is `ON'. However, necessary door interlock defeat feature shall also be provided for

testing purpose. Rating of components shall conform to the rating indicated in the enclosed component selection chart.

g) Audio visual annunciation system shall have at least but not limited to the following annunciation points complete with Accept/Test Preset P.B.:

i) Transformer winding temperature high.
ii) 415 V Incomer breaker tripped
iii) Boom Conveyor zero speed switch operated
iv) Boom Conveyor belt sway operated
v) Boom Conveyor pull cord switch operated
vi) Boom Conveyor brake not released.
vii) Boom Conveyor Motor overload/SPPR fault
viii) Back up limit switch operated.
ix) Wind velocity high.
x) Wind velocity very high.
xi) Slew limit switch operated.
xii) Slew drive fault.
xiii) Slew motor overload.
xiv) Slew drive lubrication system fault.
xv) Hydraulic oil temperature high.
xvi) Oil level low in hydraulic tank.
xvii) Hydraulic system filter clogged.
xviii) Bucket wheel brake not released.
xix) Bucket wheel zero speed switch fault.
xx) Bucket wheel motor overload/SPPR fault.
xxi) Power CRD motor overload.
xxii) Power CRD over tension switch operated.
xxiii) Control CRD motor overload.
xxiv) Control CRD over tension switch operated.
xxv) Travel drive brake not released.
xxvi) Travel drive motor overload/SPPR fault.
xxvii) Travel limit switch operated.
xxviii) Rail clamp not released.
xxix) DS motor overload/SPPR fault (to be provided for each motor).
xxx) HT load brake switch operated.

Annunciation system shall be similar to that of main Control Panel with 20% spare windows.

h) Separate cable reeling drum shall be provided for power & control cable. Combined trailing cable shall have 24C X 2.5 mm^2 (cu) control cable and 8 pair 1.5 mm^2 (cu) screened cable for signal and communication.

1.02.00 ON/OFF operation of Wagon tipplers shall be achieved from the respective Wagon tippler Control desk through PLC based logic. Control desk shall be provided in each Wagon tippler Control room for Control, Operation, Indication & Annunciation of Wagon Tippler equipment. Control desk shall interface with PLC for the entire operation and shall accommodate annunciation windows, ammeter, voltmeter, selector switches and indicating lamps for incomer, ammeter for outgoing motor feeder rated 30 KW and above. Other features as described above for the control desk of Stacker Reclaimer shall also be considered for Wagon Tippler.

1.03.00 MCC/DB/Local Starter Panel for Dust Suppression, Dust Extraction, Sump Pump, Coal Sampler, Bunker Level and other Panels

1.03.01 The Local Starter Panel shall be fixed type with compartmentalized execution. One (1) number 415 V ± 10% 3 phase 4 wire 50 Hz ± 5% power supply feeder shall be provided for each panel. Power shall be received through an incoming SFU having R/Y/B indication lamps, voltmeter with selector switch, ammeter with selector switch. Individual motor feeder shall have their switch fuse, power contactor, overload relay-cum-single phasing preventor (hand reset type), stop/ start push button, auto/manual selector switch, Red/Green/ Trip indication lamp, auxiliary relays, timers, etc. The stop push button shall be lockable type. Necessary interlock, annunciation, 415/240 V Transformers for control supply, space heating as applicable to meet system requirement shall also be provided and in no case derive any power supply from its main feeder. Separate feeders shall also be provided for brakes and rail clamp as applicable. Facility shall be provided for resetting the motor overload relay from outside without opening the panel door. Panel door shall be interlocked with the incoming Switch such that the door can not be opened when Switch is ON.

Specification requirement of the above including module selection chart will be governed by 415 V MCC/PMCC Specification.

1.03.02 Interlock, control, indication, annunciation etc. shall be achieved by relay logic

1.03.03 Isolation of individual circuit in the MCC/DB/Local Starter Panel shall be provided through individual Fuse.

1.03.04 Control features as described under relevant mechanical section shall be considered for interlocking and preparation of control schematic.

1.03.05 Thermostatically control space heater shall be provided.

1.03.06 Necessary door interlock defeat feature shall also be provided for testing purpose. Wherever necessary, the panels shall be designed for outdoor and of weather proof/rain protection type. Ratings of components shall be as per module selection chart indicated under 415 V PCC/PMCC/MCC Specification.

1.03.07 Travelling Tripper DB cum Control Panel

In addition to indication to be provided for drives, following indications shall also be provided in local panel:

i) Brakes applied
ii) Rail clamps applied
iii) Flap Gate position
iv) Travel driver over speed
v) Travelling tripper – Forward/Reverse
vi) Cable Reeling Drum on

Travelling tripper position on bunker shall be provided in the PLC.

Control features as described under relevant mechanical portion shall be considered for interlocking and preparation of control schematic.

Cable reeling drum shall be provided for power & control cable. Apart from meeting the requirements in respect of control , indication & annunciation and telecommunication following spare cores shall be provided:

i) 4 pair core (Sheilded) for communication.
ii) 4 Core for control.

1.03.08 Sump Pump Control Panel

Sump Pump Control Panel shall be provided with level controller, necessary contacts to start pumps in auto mode when level reaches high. Further, very high level shall cause hooter to blare and the same shall stop after sometime delay. In manual mode it shall be possible to start individual pump. However, in manual mode and auto mode of operation, pump shall be tripped when level in the sump pit reaches low.

In addition to other indicating lamps level high indication lamp shall also be provided in local panel.

1.03.09 Miscellaneous Control Panels

Miscellaneous control panel i.e. dust suppression panel, ventilation panel, etc. shall have individual starter feeder for individual drive. Other features as specified above shall also be provided. Equipment such as Vibrating Grizzle feeders, Magnetic separators, Metal detectors, Dust suppression, Ventilation, Dust extraction, Coal Sampler, Bunker Level, Hoists etc. shall have individual starter-cum-control panels to suit individual requirements. The panels shall include all necessary feeders, start stop PB, indicating lamp, annunciation system, 415/240V control transformers for control supply and space heating as applicable to meet system requirement. For Magnetic Separators, separate panels shall be provided. One panel shall accommodate transformer & rectifier and the other panel shall accommodate incomer and other controlling items.

The requirement of 4-20 mA signals for Belt Weigher and bunker level indicator have been spell out in Mechanical Specification and accordingly the same shall be provided.

2.00.00 SPECIFIC DESIGN REQUIREMENT

2.01.00 Construction

a) Stacker/Reclaimer/ Wagon Tippler Control Desk

Ammeters and annunciation facia shall be mounted on the vertical portion of the panel and all push button; selector switches; indication lamps etc. shall be mounted on the desk portion. The front desk shall be with top inclined downward towards front. A removable type front door shall be provided on the desk portion along with a lockable and lift-off rear door for the panel portion of the desk-cum-panel.

Travelling Tripper/Magnetic Separator/Metal Detector/Dust Extraction/ Dust Suppression/Ventilation/Coal Sampler/Bunker Level indication, Hoist/MCC/DB/Starter-Cum-Control Panel, Misc. Control Stations, Push Button Stations & Local Information Boards.

These panels/stations shall be furnished in sheet steel enclosures suitable for wall/column/floor mounting.

2.02.00 General

a) Design, material selection and workmanship shall be such as to present a neat appearance outside and inside with no marks of welds, rivets, screws or bolt heads apparent from the exterior surface of the frames.

b) Panels shall be of folded sheet steel construction, assembled on channel/angle base plates. Anti-vibration mountings shall be provided for moving equipment.

c) The panels shall be fabricated of not less than 14 SWG sheet steel free from all surface defects. The panels shall have sufficient structural reinforcement to ensure a plain surface, limit vibration and provide rigidity during despatch and installation. Vertical panels shall be freestanding type.

d) Sufficient inter-component spacing shall be available for easy maintenance, replacement, ventilation etc. of the components. A minimum spacing of 50mm is recommended for the same.

e) All doors, covers etc. shall be properly gasketted to make the panel effectively vermin and dust proof. Door hinges shall be concealed type. Special dust protection measures shall be taken for panels located in dusty area.

f) All hardware for the complete installation of the equipment including foundation and fixing bolts, nuts, washers etc. shall be supplied to suit

the requirement. All bolts, nuts etc. exposed to external atmosphere shall be cadmium plated or zinc passivated.

g) The panels shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

h) Shock absorbers shall be provided for panels mounted on mobile machines.

i) Maximum and minimum height of the operating devices on all panels except Local Control Stations shall be restricted to 1800 mm and 750 mm respectively from the floor level.

VOLUME : IIF/1

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

CONTENT

VOLUME : IIF/1

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

1.00.00 SCOPE

1.01.00 This section covers the general requirements of the drive motors for power station auxiliary equipment.

1.02.00 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.

1.03.00 In case of any discrepancy, the driven equipment specification shall govern.

2.00.00 STANDARDS

2.01.00 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/ Publications except when otherwise stated herein or in the driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed :

IS-325

IS-12615

IEC-34

3.00.00 SERVICE CONDITIONS

3.01.00 The motors will be installed in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure to this specification.

3.03.00 For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 **TYPE AND RATING**

4.01.00 **A.C. Motors**

4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.

4.01.02 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

4.01.03 The motor name-plate rating at 50°C shall have at least 10% margin over the input power requirement of the driven HT equipment and 15% for LT driven equipment at rated duty point unless stated otherwise in driven equipment specification or in general electrical specification.

4.01.04 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

4.01.05 All HT & LT motors shall be energy efficient type as per IS. However for HT motors, if the same is not specified in IS, minimum efficiency of all HT motors shall be considered as 90%.

4.02.00 **D.C. Motors**

4.02.01 D.C. motor provided for emergency service shall be shunt/compound wound type. All DC motors shall be energy efficient type with minimum efficiency of 80%.

4.02.02 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.

5.00.00 **PERFORMANCE**

5.01.00 **Running Requirements**

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure

5.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

5.01.03 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

5.02.00 **Starting Requirements**

Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all HT motors except boiler feed pump motor where the starting current shall be limited to 4.5 times. No further tolerances are applicable on starting current specified above

for HT motors. For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

5.02.01 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.02 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminal except BFP motor. In case of BFP motor, it shall be 80% rated voltage. Minimum starting requirement for mill motor (double cage) shall be 80% rated voltage at motor terminals. However for mill motors if the minimum starting voltage is more than 80% rated voltage at motor terminal and within 90% rated voltage, bidder shall provide necessary arrangement to keep the motor terminal voltage above that voltage to achieve smooth start of the motor.

5.02.03 a) Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition.

b) Cranking motor shall be capable of six equally spread starts per hour, three starts in quick succession from cold condition and one restart from hot condition. The coal conveyor and crusher motors shall be suitable for 3 consecutive hot starts with maximum 20 starts per day.

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

5.02.04 HT pump motors shall be suitable to start with forward rotation.

5.02.05 The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage

5.03.00 **Stress During Bus Transfer**

5.03.01 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

5.03.02 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

5.04.00 **Locked Rotor Withstand Time**

5.04.01 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 2.5 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.

5.04.02 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

6.00.00 **SPECIFIC REQUIREMENTS**

6.01.00 **Enclosure**

6.01.01 All motor enclosures for outdoor, semi-outdoor & indoor application shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction with canopy.

6.01.02 Motors for circulating water pumps of large output ratings, located indoor and not directly exposed to coal dust or fly ash, could have screen protected drip proof enclosure conforming to IP-23.

6.01.03 For hazardous area approved type of increased safety enclosure shall be furnished.

6.02.00 **Cooling**

6.02.01 The motor shall be self ventilated type, either totally enclosed fan cooled (TEFC) or closed air circuit air- cooled (CACA) or totally enclosed tube ventilated (TETV) type. Totally enclosed tube ventilated (TETV) type motors shall be acceptable for HT motors only.

6.02.02 For large capacity motors, closed air circuit water cooled (CACW) may be considered for acceptance.

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

6.03.02 All motors shall have class F insulation but limited to class B temperature rise.

6.03.03 Windings shall be impregnated to make them non-hygroscopic and oil resistant.

6.04.00 **Tropical Protection**

6.04.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

6.04.02 All fittings and hardwares shall be corrosion resistant.

6.05.00 **Bearings**

6.05.01 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application.

6.05.02 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

6.05.03 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

6.05.04 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

6.05.05 Grease lubricated bearings shall be prelubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication.

6.05.06 Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

6.05.07 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.

6.05.08 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

6.05.09 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

6.06.00 **Noise & Vibration**

6.06.01 The noise level shall not exceed 85db (A) at 1.5 metres from the motor at no load condition.

6.06.02 The peak amplitude of the vibration shall be within IS/IEC specified limits.

6.07.00 **Motor Terminal Box**

6.07.01 HT Motor terminal box (Phase side) shall be Phase Segregated (PSTB) type and LT motor terminal box shall be non-phase segregated type. Both HT & LT motor terminal box shall be located in accordance with Indian Standards clearing the motor base- plate/ foundation.

6.07.02 Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. for HT motors and 90 Deg. for LT motors unless otherwise approved.

6.07.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

6.07.04 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

6.07.05 Motor main terminal box shall be located right hand side of motor body looking from driving end.

6.07.06 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

6.07.07 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

6.07.08 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.07.09 HT motor phase side terminal box shall be phase-segregated type and HT motor neutral leads shall be brought out in a separate terminal box preferably

opposite side of phase terminal box & may not be necessarily phase segregated type with shorting links for star connection.

6.07.10 Motor terminal box shall be furnished with suitable cable lugs and nickel plated double compression brass glands to match with cable used.

6.07.11 The gland plate for single core cable shall be non-magnetic type.

6.08.00 **Grounding**

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

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

HT Motor (11kV, 6.6kV & 3.3 kV)	:	75 X 10 mm GS Flat
LT Motor above 90 KW	:	50 x 6 mm GS Flat
Motor above 30 KW up to 90 KW	:	35 x 6 mm GS Flat
Motor above 5 KW up to 30 KW	:	25 x 3 mm GS Flat
Motor up to 5 KW	:	8 SWG GI Wire

6.08.03 The cable terminal box shall have a separate grounding pad.

6.09.00 **Rating Plate**

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

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

b) Degree of protection.

c) Bearing identification no. and recommended lubricant.

d) Location of insulated bearings.

7.00.00 **ACCESSORIES**

7.01.00 **General**

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 **Space Heater**

7.02.01 Motor of rating 30 KW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 phase 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.03.00 **Temperature Detectors**

7.03.01 All 11000V, 6600V and 3300V motors shall be provided with twelve (12) nos. simplex type winding temperature detectors, four (4) nos. per phase. Six (6) nos. duplex type winding temperature detectors, two (2) nos. per phase shall only be acceptable for special application motors only subject to approval of owner.

7.03.02 11000V, 6600V and 3300V motor bearing shall be provided with duplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.

7.03.04 Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS connectivity.

7.03.05 Five numbers of Temperature detectors / thermisters shall be provided for L.T. motors above 90 KW (3 nos. winding temperatures & 2 nos. bearing temperatures)

7.04.00 **Indicator/Switch**

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following:

a) 11000 V, 6600V and 3300V motor bearing temperature.

b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.

7.04.03 Alarm switch contact rating shall be minimum 0.5 A at 220V D.C. and 5A at 240V A.C.

7.05.00 **Current Transformer for Differential Protection**

7.05.01 Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 nos. CT for mounting on switchgear side shall be in bidder’s scope.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.

7.06.00 **Accessory Terminal Box**

7.06.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.

7.06.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

7.08.00 **Lifting Provisions**

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

7.09.00 **Dowel Pins**

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

7.10.00 **Painting**

Motor including fan shall be painted with corrosion proof paints of colour battle ship grey shade 632 of IS-5.

8.00.00 **TESTS**

Routine and Type Tests are to be conducted in presence of customer's representative as per IS:325 and required copies of test certificates are to be furnished for approval. In addition, following tests shall have to be carried out on the motors in presence of OWNER's representative on 3.3kV/6.6kV/11kV motors.

a. Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-60034, part -15 test voltages as under :

Voltage rating of motor	Impulse Test Voltage
3.3 kV	18 kV peak
6.6 kV	31 kV peak
11 kV	49 kV peak

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

c. Polarization Index Test as per IS:7816 as routine test

d. Test for suitability of IPW– 55 (Weather proof) as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied.

Second numeral test shall be carried out on one motor of each type and rating.

e. Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box.

f. Test for noise level as routine test.

g. Test for vibration as routine test.

h. Tan delta measurement on coils.

i. Surge withstand test for inter turn insulation.

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

Furnished type test certificates of motor shall not be older than five (5) years from the date of Inspection, otherwise type test shall be conducted without any price implication.

9.00.00 DRAWINGS, DATA & MANUALS

Drawings, data & manuals for the motors shall be submitted as indicated below:

9.01.00 Along with the bid

a) List of the motors

b) Individual motor data sheet as per format of the proposal data sheets.

c) Scheme & write up on forced lubrication system, if any

d) Type test report

9.02.00 After Award of the Contract

a) Dimensional General Arrangement drawing

b) Foundation Plan & Loading

c) Cable end box details

d) Space requirement for rotor removal

e) Thermal withstand curves hot & cold

f) Starting and speed torque characteristics at 80% & 100% voltage

g) Complete motor data

h) Erection & Maintenance Manual

i) Test reports

j) Data sheets to be enclosed

ANNEXURE-A
DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
H.T. Supply	11000 V, 3Ø, 3W, 50 Hz, non-effectively earthed	Motors above 2000 KW & all mill motors
	Fault level 44 KA symm.	
	3300 V, 3Ø, 3W, 50 Hz, non-effectively earthed	Motors above 160 KW upto and including 2000 KW
	6600 V, 3Ø, 3W, 50 Hz, non-effectively earthed	Motors of CHP system and Water System above 160kW
	Fault level 40 KA symm for 3300V & 6600V	
L.T. Supply	415V, 3Ø, 3W, 50 Hz effectively earthed	Motors upto and including160KW
	Fault level 50 KA symm.	
	240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, space heating, A.C. control & protective devices
D.C. Supply	220V, 2W, unearthed	D.C. alarm, control & protective devices
	Fault level 25* KA.	

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage : ± 10% Frequency : ± 5% Combined Volt : 10% (absolute sum) + frequency

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage : 187 to 242 Volt

SECTION – C3

SPECIFIC TECHNICAL REQUIREMENTS (CIVIL)

WANAKBORI TPS UNIT-III, (1 X 800 MW)

3.00.00	**GEO-TECHNICAL INVESTIGATION & FOUNDATION SYSTEM**
3.01.01	BHEL had carried out detailed geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at various bore holes (BH-30, 31, 32, 33, 34, 61 & 62) in the cooling tower area are enclosed as Annexure-1 The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms & conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.
3.01.02	Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work. However, the net safe bearing capacity (SBC) of shallow foundation to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of net SBC higher than the one indicated shall not be accepted. However, bidder shall note that the net safe bearing capacity and foundation depth/ safe load carrying capacity of pile to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.
3.02.00	**Foundation System**
3.02.01	General Requirements a. All equipments/structures shall be supported on suitable open foundation along with any special requirements/remedial measures/treatment called for subsoil/foundations as approved by BHEL/owner.

	b. All foundations shall be designed in accordance with the provisions of relevant part of the latest revision of Indian Standards. c. No foundation shall rest on filled up soil./Loose soil d. No foundation shall rest on expansive soil. e. A combination of open and pile foundations shall not be permitted under the same structure. f. Foundations shall be designed to resist loading derived from environmental loads including loads due to wave, current, wind or seismic, gravity loads, construction loads, static and moving loads and any other loads as applicable and as specified elsewhere in the specification. g. Foundation shall be designed for worst combination of loads as described elsewhere in the specification.
3.02.02	**Open foundations** In case shallow/open foundations are adopted then the following shall be strictly adhered to.
	i. Minimum width of foundation shall be 1m. ii. Minimum founding level shall be as mentioned in Table-1. iii. The net safe bearing capacity (SBC) of shallow/open foundations at different founding level shall be limited to the values as mentioned in the following Table-1 and any value of net SBC higher than the one indicated shall not be accepted. However, bidder shall note that the net safe bearing capacity and depth of foundation to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.

Table-1

Net Safe Bearing Capacity

Unit	Type of Foundation	Founding Level (m)	Net Safe Bearing capacity (T/sq.m)	Finished Ground Level (FGL) (m)	Remarks
1	Isolated/Raft	(+)71.00	10	R.L (+)72.000	Minimum founding level shall be RL(+)71.00M
2	Isolated/Raft	(+)70.00	18		
3	Isolated/Raft	(+)69.00	28		
4	Isolated/Raft	(+)68.00	40		
5	Isolated/Raft	(+)67.00	42		

iv. It shall be ensured that all foundations of a particular structure/building/equipment shall rest on one bearing stratum.

v. The permissible settlement as mentioned under para “permissible settlement of foundations” or permissible settlement from functional requirement which ever more stringent shall be adopted for the design.

vi. The permissible total settlement and differential settlement of foundation resting on soil mass shall be governed by IS

	: 1904 and from functional requirements whichever is more stringent. Unless otherwise mentioned, the total settlement of cooling tower foundation resting on soil shall be restricted to 25mm. vii. Analysis and proportioning of footings to minimize differential settlements shall be carried out for all major foundations and the same shall be submitted for BHEL/owner's approval. viii. In case any soft soil/loose stratum is met with at the founding level or below during execution, the same shall be completely removed and filled back with PCC 1(cement):3(sand):6(stone aggregates) up to desired foundation level. ix. Expansive soil shall not be used for filling/back filling around foundation x. No foundation shall be resting on expansive soil.
3.02.02	**Pile foundations** In case pile foundations are adopted, then the following shall be strictly adhered to a. Pile foundation shall be bored cast-in-situ RCC pile as per IS: 2911 part-1 section-2. Flushing of pile bore shall be done as per IS-2911 part-1, section 2 to ensure proper cleaning. The construction methodology to be adopted shall be suitable to ensure proper termination of pile in the desired strata and to ensure pile bore free from spoils. b. Only RCC pile shall be provided. c. Minimum diameter of pile shall be 600 mm. d. Minimum length of pile shall be 15m below cut off level. Cut off level shall be at least 4m below ground level. e. The allowable load carrying capacity of the pile in vertical compression shall be limited to its structural capacity. However, the pile capacity to be adopted for design shall be the least of the estimated design value and that obtained from the pile load test. Maximum

permissible lateral deflection at pile head shall be 5mm.

f. Only straight shaft piles shall be used.

g. Minimum cover to main reinforcement in the pile shall be 75mm.

h. The piling work shall be carried out in accordance with the provisions of IS: 2911 (relevant part) and approved construction methodology. Minimum grade of concrete shall be M-25 with cement content not less 400 Kg/cu.m.

i. The actual length of pile shall in no case be less than the design length. However, the safe load carrying capacity of pile shall be limited to the following Table-2.

Table-2

Safe Load Carrying Capacity of Bored Cast-in-situ RCC Piles

SL. No	Pile dia (mm)	Pile capacity in vertical compression (MT)	Pile capacity in lateral (MT)	Pile capacity in Uplift (MT)
1	600	140	13.5	35
2	760	200	17	50

j. Bidder shall furnish the design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile, reinforcement for job piles and test piles etc.), construction methodology/ specification for construction of piles and scheme of initial pile load tests in vertical, lateral and uplift load carrying capacities for BHEL/owner's approval.

k. Regular quality assurance checks for density of circulation mud, contamination mud and samples from pile bore bottom, slump of concrete, pile concrete integrity etc. shall be done by the bidder

3.02.03	**Pile Load Tests**

	Bidder shall install piles for initial load test. Minimum number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under. 1. Vertical (compression) 2 2. Lateral (horizontal) 2 3. Uplift (tension) 2 The initial pile load test shall be conducted up to a maximum test load of two and half times the estimated safe load carrying capacity of pile. In case of compression test, the method of loading shall be cyclic as per IS: 2911 (relevant part). The routine load test on pile shall be conducted upto a maximum test load of one and half times the allowable pile capacity as per relevant Indian Standards. Number of routine pile load tests to be performed for each diameter/ allowable capacity of pile in vertical compression and lateral load shall be at least 1.5% of total number of job piles in each case. Piles for routine load test shall be approved by BHEL/owner. Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911, Part-4. Bidder shall ensure that all equipments/ instruments are properly calibrated at a reputed laboratory/institution prior to their use and the calibration test certificates shall be submitted to BHEL/owner. A report on the pile load tests shall be submitted for BHEL/owner's approval. In case, pile has not achieved the desired capacity after routine pile load test or piles have been rejected due to any other reason, then the bidder shall install additional pile(s) as required at his/her own cost and accordingly pile cap design shall also be reviewed and modified (if required) at no extra cost to BHEL/owner.
3.02.04	**Pile Integrity Test:** Low strain pile integrity test shall be conducted on all job/test piles. The testing shall confirm to relevant ASTM.

ANNEXURE-1

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat. CETEST

Job No : 3369 | **Created by : Chandrani** | **Created on : 15/01/2015** | **Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.30

Co-ordinates E=313.000 N=150.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 29/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.844 m.
Water Struck At :
Standing Water Level : 25.1 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of brownish grey, sandy silt with coal dust & gravels.		10 19 21 (40)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.15
3.00m.		3 4 8 (12)	SPT-2	3.00-3.45
Medium dense, brownish grey, silty sand sand with traces of clay binders.			UDS-2	4.00-4.45
		5 7 11 (18)	SPT-3	5.00-5.45
			DS-2	6.00
			UDS-3	6.50-6.95
			DS-3	7.50
		7 10 13 (23)	SPT-4	8.00-8.45
			DS-4	9.00
			UDS-4	9.50-9.95
10.00m.			DS-5	10.50
		9 17 29 (46)	SPT-5	11.00-11.45
			DS-6	12.00
		22 36 43 (79)	*UDS-5	12.50-12.63
Hard, brownish grey, clayey silt with traces of sand mixture. Obs. gravels.			SPT-6	12.63-13.08
			DS-7	13.50
		28 32 46 (78)	SPT-7	14.00-14.45
			DS-8	15.00
		23 41 48 (89)	SPT-8	15.50-15.95
16.50m.			DS-9	16.50
		32 46 52 (>100) 11.0 cm Pentn.	SPT-9	17.00-17.41
Very dense, brownish grey, clayey sandy silt.			DS-10	18.00
		38 42 55 (>100) 8.0 cm Pentn.	SPT-10	18.50-18.88
			DS-11	19.50
20.00m.				
Very dense, brownish grey, silty sand.		29 48 56 (>100) 7.0 cm Pentn.	SPT-11	20.00-20.37
20.75m.				

BH-30/Sheet-1

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
Job No : 3369	Created by : Chandrani	Created on : 15/01/2015	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.30

Co-ordinates E=313.000 N=150.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 29/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.844 m.
Water Struck At :
Standing Water Level : 25.1 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
			DS-12	21.00
		≥100	SPT-12	21.50-21.89
		33 47 53 9.0 cm Pentn.	DS-13	22.50
		≥100	SPT-13	23.00-23.26
		31 54 11.0 cm Pentn.	DS-14	24.00
		≥100	SPT-14	24.50-24.73
Very dense, brownish grey, silty sand.		36 52 8.0 cm Pentn.	DS-15	25.50
		≥100	SPT-15	26.00-26.25
		30 59 10.0 cm Pentn.	DS-16	27.00
		≥100	SPT-16	27.50-27.73
		35 54 8.0 cm Pentn.		
28.50m			DS-17	28.50
		≥100	SPT-17	29.00-29.37
		39 49 52 7.0 cm Pentn.	DS-18	30.00
		≥100	SPT-18	30.50-30.76
Very dense, brownish grey, clayey sandy silt.		36 59 11.0 cm Pentn.	DS-19	31.50
		≥100	SPT-19	32.00-32.28
32.00m		40 67 13.0 cm Pentn.	DS-20	33.00
		≥100	SPT-20	33.50-33.90
		33 40 57 10.0 cm Pentn.	DS-21	34.50
		≥100	SPT-21	35.00-35.38
		38 45 55 8.0 cm Pentn.	DS-22	36.00
		≥100	SPT-22	36.50-36.73
Very dense, brownish grey, silty sand with gravels.		42 58 8.0 cm Pentn.	DS-23	37.50
		≥100	SPT-23	38.00-38.22
		46 56 7.0 cm Pentn.	DS-24	39.00
		≥100	SPT-24	40.00-40.22
40.22m		57 52 7.0 cm Pentn.		

N.B. – '*' means sample could not be recovered.

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat. CETEST

Job No : 3369 | **Created by : Chandrani** | **Created on : 15/01/2015** | **Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.31

Co-ordinates E=296.000 N=89.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	25	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	25
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 26/12/14
Completion Date : 29/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.905 m.
Water Struck At :
Standing Water Level : 26.0 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of light grey / brownish grey, sandy silt with ash & gravels. 1.00m.		7 13 19 = 32	DS-1	0.50
			SPT-1	1.00-1.45
Blackish grey, coal with gravels. 3.00m.		8 11 17 = 28	*UDS-1	2.00-2.13
			SPT-2	2.13-2.58
		6 8 9 = 17	SPT-3	3.00-3.45
Medium dense, yellowish brown, sandy silt. 6.00m.		6 12 17 = 29	UDS-2	4.00-4.45
			SPT-4	5.00-5.45
			DS-2	6.00
			UDS-3	6.50-6.95
			DS-3	7.50
Hard, yellowish brown, clayey silt with sand mixture. 10.50m.		9 16 21 = 37	SPT-5	8.00-8.45
			DS-4	9.00
			UDS-4	9.50-9.95
			DS-5	10.50
Very dense, brownish grey, sandy silt with concreation of silt. 12.00m.		15 35 44 = 79	SPT-6	11.00-11.45
			DS-6	12.00
		12 29 38 = 67	SPT-7	12.50-12.95
			DS-7	13.50
		20 39 49 = 88	SPT-8	14.00-14.45
			DS-8	15.00
Very dense, brownish grey, sandy silt. 19.00m.		22 41 52 = 93	SPT-9	15.50-15.95
			DS-9	16.50
		24 50 63 = >100 (11.0 cm Pentn.)	SPT-10	17.00-17.41
			DS-10	18.00
		28 50 50 = >100 (9.0 cm Pentn.)	SPT-11	18.50-18.89
Very dense, deep grey, silty sand with mica. 20.75m.		19 50 50 = >100 (7.0 cm Pentn.)	DS-11	19.50
			SPT-12	20.00-20.37

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
Job No : 3369	Created by : Chandrani	Created on : 15/01/2015	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.31

Co-ordinates E=296.000 N=89.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	25	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	25
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 26/12/14
Completion Date : 29/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.905 m.
Water Struck At :
Standing Water Level : 26.0 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m.			DS-12	21.00
		30 42 59 >100	SPT-13	21.50-21.95
			DS-13	22.50
		15 38 54 92	SPT-14	23.00-23.45
Very dense, deep grey, silty sand with mica.			DS-14	24.00
		42 58 60 >100 9.0 cm Pentn.	SPT-15	24.50-24.89
			DS-15	25.50
		32 46 51 >100 9.0 cm Pentn.	SPT-16	26.00-26.39
			DS-16	27.00
27.50m.		29 43 50 >100 7.0 cm Pentn.	SPT-17	27.50-27.87
			DS-17	28.50
		35 45 52 >100 7.0 cm Pentn.	SPT-18	29.00-29.37
Very dense, brownish grey, silty sand. Obs. concreation of silt.			DS-18	30.00
		43 52 50 >100 4.0 cm Pentn.	SPT-19	30.50-30.84
			DS-19	31.50
		56 60 >100 12.0 cm Pentn.	SPT-20	32.00-32.27
33.00m.			DS-20	33.00
		48 50 >100 9.0 cm Pentn.	SPT-21	33.50-33.74
			DS-21	34.50
		45 58 >100 13.0 cm Pentn.	SPT-22	35.00-35.28
			DS-22	36.00
Very dense, brownish grey, sandy silt / silty sand. Obs. mica.		49 56 >100 8.0 cm Pentn.	SPT-23	36.50-36.73
			DS-23	37.50
		44 55 >100 10.0 cm Pentn.	SPT-24	38.00-38.25
			DS-24	39.00
40.22m.		48 53 >100 7.0 cm Pentn.	SPT-25	40.00-40.22

N.B. - '*' means sample could not be recovered.

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
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BORE LOG DATA SHEET

BORE HOLE NO.32

Co-ordinates E=271.000 N=38.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 24/12/14
Completion Date : 27/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.915 m.
Water Struck At :
Standing Water Level : 26.1 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of brownish grey, sandy silt.			DS-1	0.50
1.00m. Filled up soil consists of dense, deep grey, sandy silt with ash & gravels.		7 19 23 (42)	SPT-1	1.00-1.45
			UDS-1	2.00-2.45
2.50m. Medium dense, brownish grey, silty sand with traces of mica.		3 4 7 (11)	SPT-2	3.00-3.45
			UDS-2	4.00-4.45
		5 7 9 (16)	SPT-3	5.00-5.45
6.00m. Medium dense, yellowish brown, silty sand with traces of mica. Obs. concreation of silt.			DS-2	6.00
			UDS-3	6.50-6.95
			DS-3	7.50
		10 12 13 (25)	SPT-4	8.00-8.45
			DS-4	9.00
9.50m. Very stiff, brownish grey, clayey silt.			UDS-4	9.50-9.95
			DS-5	10.50
		7 11 13 (24)	SPT-5	11.00-11.45
11.50m. Hard, brownish grey, clayey silt with sand mixture.			DS-6	12.00
			*UDS-5	12.50-12.65
		14 26 32 (58)	SPT-6	12.80-13.25
			DS-7	13.55
		20 34 38 (72)	SPT-7	14.00-14.45
			DS-8	15.00
		28 42 54 (>100) 10.0 cm Pentn.	SPT-8	15.50-15.90
			DS-9	16.50
		30 48 52 (>100) 7.0 cm Pentn.	SPT-9	17.00-17.37
18.00m. Very dense, brownish grey, clayey sandy silt.			DS-10	18.00
		26 46 57 (>100) 9.0 cm Pentn.	SPT-10	18.50-18.89
			DS-11	19.50
20.75m.		21 43 53 (>100) 10.0 cm Pentn.	SPT-11	20.00-20.40

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
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BORE LOG DATA SHEET

BORE HOLE NO.32

Co-ordinates E=271.000 N=38.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 24/12/14
Completion Date : 27/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.915 m.
Water Struck At :
Standing Water Level : 26.1 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m Very dense, brownish grey, clayey sandy silt.		≥100 23 48 56 7.0 cm Pentn.	DS-12 SPT-12	21.00 21.50-21.87
22.50m Very dense, brownish grey, silty sand.		≥100 46 50 5.0 cm Pentn.	DS-13 SPT-13	22.50 23.00-23.20
24.00m Very dense, brownish grey, silty sand with concreation of silt.		≥100 28 42 56 8.0 cm Pentn.	DS-14 SPT-14	24.00 24.50-24.88
26.00m Very dense, brownish grey, silty sand with traces of kankars & clay binders.		≥100 38 55 9.0 cm Pentn. ≥100 30 50 10.0 cm Pentn.	DS-15 SPT-15 DS-16 SPT-16	25.50 26.00-26.24 27.00 27.50-27.675
29.00m Very dense, brownish grey, silty sand with traces of kankars & clay binders.		≥100 24 43 52 12.0 cm Pentn. ≥100 27 46 50 7.0 cm Pentn.	DS-17 SPT-17 DS-18 SPT-18	28.50 29.00-29.42 30.00 30.50-30.87
31.50m Very dense, brownish grey, silty sand / sandy silt.		≥100 33 44 52 9.0 cm Pentn. ≥100 42 54 13.0 cm Pentn. ≥100 38 53 9.0 cm Pentn. ≥100 45 50 8.0 cm Pentn. ≥100 41 52 7.0 cm Pentn.	DS-19 SPT-19 DS-20 SPT-20 DS-21 SPT-21 DS-22 SPT-22 DS-23 SPT-23	31.50 32.00-32.39 33.00 33.50-33.78 34.50 35.00-35.24 36.00 36.50-36.73 37.50 38.00-38.22
40.24m N.B. - '*' means sample could not be recovered.		≥100 45 50 9.0 cm Pentn.	DS-24 SPT-24	39.00 40.00-40.24

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
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BORE LOG DATA SHEET

BORE HOLE NO.33

Co-ordinates E=386.000 N=132.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 28/12/14
Completion Date : 31/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 76.477 m.
Water Struck At :
Standing Water Level : 23.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of brownish grey / deep grey, sandy silt with ash & gravels.			DS-1	0.50
1.00m.		4 0 0 0 9/4 5	SPT-1	1.00-1.45
Filled up soil consists of blackish grey, coal dust & gravels.			UDS-1	2.00-2.45
2.00m.				
Medium dense, yellowish brown, silty sand with traces of mica. Obs. reddish brown patches.		5 7 10 17	SPT-2	3.00-3.45
4.00m.			UDS-2	4.00-4.45
		8 13 15 28	SPT-3	5.00-5.45
Medium dense, yellowish brown, silty sand with traces of mica.			DS-2	6.00
			UDS-3	6.50-6.95
7.50m.			DS-3	7.50
		9 14 18 32	SPT-4	8.00-8.45
Dense, brownish grey, clayey sandy silt with concreation of silt.			DS-4	9.00
9.00m.			UDS-4	9.50-9.80
			DS-5	10.50
		>100	SPT-5	11.00-11.25
		44 54 10.0 cm Pentn.	DS-6	12.00
		>100	SPT-6	12.50-12.89
Hard, brownish grey, clayey silt with concreation of silt & traces of sand mixture.		37 42 52 9.0 cm Pentn.	DS-7	13.50
		>100	SPT-7	14.00-14.26
		18 54 11.0 cm Pentn.	DS-8	15.00
		>100	SPT-8	15.50-15.74
		50 50 9.0 cm Pentn.	DS-9	16.50
		>100	SPT-9	17.00-17.22
		47 54 7.0 cm Pentn.	DS-10	18.00
18.00m.		>100	SPT-10	18.50-18.70
		60 50 5.0 cm Pentn.	DS-11	19.50
Very dense, brownish grey, silty sand / sandy silt.		>100	SPT-11	20.00-20.23
		49 54 8.0 cm Pentn.		
20.75m.				

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
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BORE LOG DATA SHEET

BORE HOLE NO.33

Co-ordinates E=386.000 N=132.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	4
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 28/12/14
Completion Date : 31/12/14
Bore Hole Diameter : 150 mm.
Level Of Ground : 76.477 m.
Water Struck At :
Standing Water Level : 23.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m			DS-12	21.00
Very dense, brownish grey, silty sand / sandy silt.		24 37 42 79	SPT-12	21.50-21.95
21.50m			DS-13	22.50
Hard, brownish grey, clayey silt with traces of sand mixture. Obs. mica & gravels.		23 39 45 84	SPT-13	23.00-23.45
24.00m			DS-14	24.00
		20 48 55 >100 10.0 cm Pentn.	SPT-14	24.50-24.90
Very dense, brownish grey, silty sand.			DS-15	25.50
		37 44 54 >100 5.0 cm Pentn.	SPT-15	26.00-26.35
27.00m			DS-16	27.00
		48 52 >100 10.0 cm Pentn.	SPT-16	27.50-27.75
Very dense, brownish grey, silty sand with concreation of silt & gravels.			DS-17	28.50
29.00m		43 54 >100 8.0 cm Pentn.	SPT-17	29.00-29.23
			DS-18	30.00
		30 47 54 >100 5.0 cm Pentn.	SPT-18	30.50-30.85
			DS-19	31.50
		44 54 >100 9.0 cm Pentn.	SPT-19	32.00-32.24
			DS-20	33.00
		53 50 >100 7.0 cm Pentn.	SPT-20	33.50-33.72
Very dense, brownish grey, silty sand with high % of gravels & pebbles.			DS-21	34.50
		49 54 >100 8.0 cm Pentn.	SPT-21	35.00-35.23
			DS-22	36.00
		60 52 >100 9.0 cm Pentn.	SPT-22	36.50-36.74
			DS-23	37.50
		54 50 >100 7.0 cm Pentn.	SPT-23	38.00-38.22
			DS-24	39.00
40.23m		52 54 >100 8.0 cm Pentn.	SPT-24	40.00-40.23

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat. CETEST

Job No : 3369 | **Created by : Chandrani** | **Created on : 15/01/2015** | **Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.34

Co-ordinates E=430.000 N=90.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	6
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 28/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.385 m.
Water Struck At :
Standing Water Level : 25.45 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of brownish grey, sandy silt with ash & gravels.			DS-1	0.50
1.00m.		4 5 6 (11)	SPT-1	1.00-1.45
			UDS-1	2.00-2.45
		3 5 5 (10)	SPT-2	3.00-3.45
Medium dense, greyish brown, silty sand with traces of mica. Obs. coal dust patches.			UDS-2	4.00-4.45
		5 8 9 (17)	SPT-3	5.00-5.45
			DS-2	6.00
			UDS-3	6.50-6.95
			DS-3	7.50
8.00m.		8 10 11 (21)	SPT-4	8.00-8.45
			DS-4	9.00
Medium dense, brownish grey, silty sand with clay binders.			UDS-4	9.50-9.95
			DS-5	10.50
11.00m.		17 20 28 (48)	SPT-5	11.00-11.45
			DS-6	12.00
			*UDS-5	12.50-12.65
		12 17 21 (38)	SPT-6	12.65-13.10
			DS-7	13.50
Hard, brownish grey, clayey silt with gravels.		15 25 29 (54)	SPT-7	14.00-14.45
			DS-8	15.00
		14 32 35 (67)	SPT-8	15.50-15.95
			DS-9	16.50
		16 38 40 (78)	SPT-9	17.00-17.45
18.00m.			DS-10	18.00
		48 54 (>100) 7.0 cm Pentn.	SPT-10	18.50-18.72
Hard, brownish grey, clayey silt with traces of sand mixture.			DS-11	19.50
		24 40 52 (>100) 8.0 cm Pentn.	SPT-11	20.00-20.38
20.75m.				

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
Job No : 3369	Created by : Chandrani	Created on : 15/01/2015	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.34

Co-ordinates E=430.000 N=90.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	24	Undisturbed (UDS)	6
Cone (Pc)		Penetrometer (SPT)	24
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 28/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 79.385 m.
Water Struck At :
Standing Water Level : 25.45 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m.			DS-12	21.00
		30 45 54 (>100)	SPT-12	21.50-21.86
		6.0 cm Pentn.	DS-13	22.50
Hard, brownish grey, clayey silt with traces of sand mixture.		21 47 57 (>100)	SPT-13	23.00-23.45
			DS-14	24.00
		32 45 52 (>100)	SPT-14	24.50-24.89
		9.0 cm Pentn.		
25.50m.			DS-15	25.50
		13 16 18 (34)	SPT-15	26.00-26.45
Desne brownish grey, silty sand.			DS-16	27.00
		14 19 27 (46)	SPT-16	27.50-27.95
			DS-17	28.50
29.00m.			*UDS-6	29.00-29.15
		17 24 35 (59)	SPT-17	29.30-29.75
Very dense, brownish grey, silty sand with gravels.				
30.50m.			DS-18	30.50
		19 34 43 (77)	SPT-18	31.00-31.45
Hard, brownish grey, clayey silt with traces of sand mixture.				
32.00m.			DS-19	32.00
		38 49 54 (>100)	SPT-19	32.50-32.84
		4.0 cm Pentn.	DS-20	33.50
		34 47 52 (>100)	SPT-20	34.00-34.36
		6.0 cm Pentn.	DS-21	35.00
		45 54 (>100)	SPT-21	35.50-35.75
Very dense, brownish grey, silty sand with gravels & pebbles.		10.0 cm Pentn.	DS-22	36.50
		47 58 (>100)	SPT-22	37.00-37.22
		7.0 cm Pentn.	DS-23	38.00
		56 50 (>100)	SPT-23	38.50-38.74
		9.0 cm Pentn.	DS-24	39.50
40.23m.		60 52 (>100)	SPT-24	40.00-40.23
		8.0 cm Pentn.		

N.B. - '*' means sample could not be recovered.

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat. CETEST

Job No : 3369 | **Created by : Chandrani** | **Created on : 16/01/2015** | **Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.61

Co-ordinates E=377.000 N=65.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	25	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	25
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 31/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 80.441 m.
Water Struck At :
Standing Water Level : 24.7 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of light grey to deep grey, sandy silt. Obs. ash & gravels (coal dust).		3 5 7 — 12	DS-1	0.50
			SPT-1	1.00-1.45
			UDS-1	2.00-2.45
		5 8 9 — 17	SPT-2	3.00-3.45
4.00m.			UDS-2	4.00-4.45
Very stiff, brownish grey, clayey silt with traces of sand mixture.		6 7 9 — 16	SPT-3	5.00-5.45
			DS-2	6.00
6.50m.			*UDS-3	6.50-6.90
Dense to very dense, brownish grey, silty sand with traces of clay.		10 13 22 — 35	SPT-4	7.00-7.45
			DS-3	7.80
		12 19 35 — 54	SPT-5	8.00-8.45
			DS-4	9.00
			UDS-4	9.50-9.95
			DS-5	10.50
		29 41 42 — 83	SPT-6	11.00-11.45
			DS-6	12.00
			UDS-5	12.50-12.80
			DS-7	13.50
14.00m.		>100		
Hard, brownish grey, clayey silt with traces of sand mixture.		30 43 52 — 7.0 cm Pentn.	SPT-7	14.00-14.37
		>100	DS-8	15.00
		34 60 — 9.0 cm Pentn.	SPT-8	15.50-15.74
		>100	DS-9	16.50
		28 47 52 — 8.0 cm Pentn.	SPT-9	17.00-17.38
		>100	DS-10	18.00
18.50m.				
Hard, brownish grey, clayey sandy silt.		41 55 — 10.0 cm Pentn.	SPT-10	18.50-18.75
		>100	DS-11	19.50
		45 52 — 8.0 cm Pentn.	SPT-11	20.00-20.23
20.75m.				

BH-61/Sheet-1

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
Job No : 3369	Created by : Chandrani	Created on : 16/01/2015	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.61

Co-ordinates E=377.000 N=65.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	25	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	25
		Disturbed (DS)	24
Vane (V)		Water Sample (WS)	0

Commencement Date : 31/12/14
Completion Date : 01/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 80.441 m.
Water Struck At :
Standing Water Level : 24.7 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m.			DS-12	21.00
		>100		
		40 56 9.0 cm Pentn.	SPT-12	21.50-21.74
			DS-13	22.50
		90		
		27 37 53	SPT-13	23.00-23.45
			DS-14	24.00
		>100		
		33 41 52 9.0 cm Pentn.	SPT-14	24.50-24.89
			DS-15	25.50
		>100		
Hard, brownish grey, clayey sandy silt.		40 45 55 7.0 cm Pentn.	SPT-15	26.00-26.37
			DS-16	27.00
		>100		
		43 56 60 5.0 cm Pentn.	SPT-16	27.50-27.85
			DS-17	28.50
		>100		
		49 69 10.0 cm Pentn.	SPT-17	29.00-29.25
			DS-18	30.00
		>100		
		40 52 65 8.0 cm Pentn.	SPT-18	30.50-30.88
			DS-19	31.50
32.00m.		>100		
		43 55 65 7.0 cm Pentn.	SPT-19	32.00-32.37
			DS-20	33.00
		>100		
		44 58 65 8.0 cm Pentn.	SPT-20	33.50-33.88
			DS-21	34.50
		>100		
		49 65 15 8.0 cm Pentn.	SPT-21	35.00-35.23
			DS-22	36.00
Very dense, brownish grey, silty sand. Obs. gravels.		>100		
		53 62 13.0 cm Pentn.	SPT-22	36.50-36.78
			DS-23	37.50
		>100		
		56 51 10.0 cm Pentn.	SPT-23	38.00-38.25
			DS-24	39.00
		>100		
		51 60 6.0 cm Pentn.	SPT-24	39.50-39.71
40.18m.		>100	SPT-25	40.00-40.18
		54 51 3.0 cm Pentn.		

N.B. - '*' means sample could not be recovered.

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat. CETEST

Job No : 3369 | **Created by : Chandrani** | **Created on : 16/01/2015** | **Sheet No:**

BORE LOG DATA SHEET

BORE HOLE NO.62

Co-ordinates E=470.000 N=120.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	23	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	23
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 03/01/15
Completion Date : 05/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.12 m.
Water Struck At :
Standing Water Level : 23.25 m.

DESCRIPTION	SYMBOL	N-VALUE EACH DIVN. = 15cm.				SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Filled up soil consists of light grey, silty sand with stone chips, gravels & roots.						DS-1	0.50
1.00m. Loose, yellowish brown, silty sand with traces of kankars.		2	2	3	5	SPT-1	1.00-1.45
						UDS-1	2.00-2.45
		4	4	3	7	SPT-2	3.00-3.45
4.00m. Medium dense, brownish grey, sandy silt.						UDS-2	4.00-4.45
		5	5	7	12	SPT-3	5.00-5.45
						DS-2	6.00
						UDS-3	6.50-6.95
						DS-3	7.50
8.00m. Medium dense, greyish brown, silty sand with traces of clay binders.		5	9	11	20	SPT-4	8.00-8.45
						DS-4	9.00
						UDS-4	9.50-9.95
						DS-5	10.50
		7	9	13	22	SPT-5	11.00-11.45
						DS-6	12.00
						UDS-5	12.50-12.95
13.50m. Very dense, brownish grey, sandy silt with traces of clay. Obs. concreation of silt.						DS-7	13.50
		24	22	29	51	SPT-6	14.00-14.45
						DS-8	15.00
		25	26	32	58	SPT-7	15.50-15.95
						DS-9	16.50
		18	29	35	64	SPT-8	17.00-17.45
						DS-10	18.00
		17	22	43	65	SPT-9	18.50-18.95
						DS-11	19.50
20.75m.		21	26	47	73	SPT-10	20.00-20.45

Project : Geotech. Inv. work for 1x800 MW Wanakbori TPS, Gujarat.			CETEST
Job No : 3369	Created by : Chandrani	Created on : 16/01/2015	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.62

Co-ordinates E=470.000 N=120.000

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	23	Undisturbed (UDS)	5
Cone (Pc)		Penetrometer (SPT)	23
Vane (V)		Disturbed (DS)	24
		Water Sample (WS)	0

Commencement Date : 03/01/15
Completion Date : 05/01/15
Bore Hole Diameter : 150 mm.
Level Of Ground : 78.12 m.
Water Struck At :
Standing Water Level : 23.25 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
20.75m. Very dense, brownish grey, sandy silt with traces of clay. Obs. concreation of silt.		24 31 44 (75)	DS-12	21.00
			SPT-11	21.50-21.95
22.50m.			DS-13	22.50
Very dense, greyish brown, silty sand with mica.		37 41 60 (>100) 8.0 cm Pentn.	SPT-12	23.00-23.38
			DS-14	24.00
		43 52 50 (>100) 3.0 cm Pentn.	SPT-13	24.50-24.83
			DS-15	25.50
26.00m. Hard, brownish grey, clayey silt with traces of sand. Obs. concreation of silt.		14 25 38 (63)	SPT-14	26.00-26.45
			DS-16	27.00
		16 28 43 (71)	SPT-15	27.50-27.95
28.50m. Very dense, brownish grey, silty sand with gravels.			DS-17	28.50
		21 37 63 (>100) 5.0 cm Pentn.	SPT-16	29.00-29.35
			DS-18	30.00
		28 43 60 (>100) 7.0 cm Pentn.	SPT-17	30.50-30.87
			DS-19	31.50
		37 65 15 (>100) 13.0 cm Pentn.	SPT-18	32.00-32.28
			DS-20	33.00
		43 58 (>100) 11.0 cm Pentn.	SPT-19	33.50-33.76
			DS-21	34.50
		48 53 (>100) 7.0 cm Pentn.	SPT-20	35.00-35.22
			DS-22	36.00
		52 59 (>100) 10.0 cm Pentn.	SPT-21	36.50-36.75
			DS-23	37.50
		54 50 (>100) 8.0 cm Pentn.	SPT-22	38.00-38.23
			DS-24	39.00
40.19m.		56 52 (>100) 4.0 cm Pentn.	SPT-23	40.00-40.19

VOLUME: IIG/1

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

CONTENTS

VOLUME: IIG/1 : GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

VOLUME: IIG/1

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORKS

1.00.00 GENERAL

This specification is intended to cover general as well as technical specification required for design, supply, execution & erection of complete Civil, Structural and Architectural and miscellaneous works required for completion of 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner.

The work shall include design, construction and erection activities of both underground and above ground civil and structural works and shall include all working drawing, labor, materials, plants, equipment, transportation and all incidental items not shown or specified explicitly but reasonably implied and necessary for proper completion of the project, all in strict compliance with this specification, including the revision and amendments thereto as may be required during the execution of the work.

The work shall be carried out according to the design/drawing to be developed by the Contractor and approved by the Owner. For all building, structure, foundations, roads, drainage, necessary details and layout shall be prepared by the Contractor keeping in view the functional requirement of the plant and the facilities and providing enough space and access for operation use and maintenance. The drawings and specifications attached herewith do not provide complete description of each and every system but state the minimum functional requirement for the plant as a whole or certain individual components.

All the quality of works and standards pertaining to field and laboratory testing, excavation, concreting, fabrication, erection, welding and other technical requirements covered under this specification shall strictly conform to the respective technical specifications annexed hereto. The specifications are intended for the general description of the work, quality and workmanship. The specifications are not, however, intended to cover the minutest details and the work shall be executed according to the spirit of the specification and in the absence thereof according to the relevant latest Indian Standard Codes. In absence of the later, the work shall be executed according to the local public work department practice or to the recommendation of relevant American & British Standards or to the instruction of the Owner. The IS Codes to be followed are mentioned in the relevant Technical specification for different items of works. The bidder is expected to get clarified any doubts about the specification etc., before bidding through discussion with the Owner recorded in writing in respect of interpretation of any portion of this documents. The Owner reserves the right to alter/amend any part/criteria of this specification in the interest of the project without creating any financial implication whatsoever on the part of Owner.

Before bidding the contractor shall visit the site to get themselves fully acquainted with site condition, approaches, transport facilities, off- site facilities, availability of materials, storage space, fabrication and bar bending yard, accommodation of workmen, site office, testing laboratory and other assorted facilities. The bidder or its consultants, if any, shall have well-equipped design

office with modern drafting, computing and transmission facilities to comply with high rate of drawing/document production pertaining to civil & structural system to meet the stipulated time frame laid down in the specification. No extra claim shall be entertained for any unforeseen reason.

2.00.00 SCOPE OF CIVIL AND STRUCTURAL WORKS

The scope of civil and structural work comprises all necessary investigations, survey, foundations, building, superstructures and infrastructure required for the complete operating of power station. The scope of work includes all the following works in conformity with approved Mechanical / Electrical layout drawings but not limited to the following.

A. Site preparation

- Area Grading, leveling and dressing

  a) Finished Grade Level to be raised to RL 72.0M in Power block area. FGL of CHP area will be at RL 78M. Area grading and filling work for the entire plant area to be included as per levels shown in tender drawing (K9213R-DWG-S-0002). The land filling work shall also include construction of embankment and filling for extension of coal stockyard towards existing effluent pond at 800E.

  b) All slope Protection work and other necessary works to be considered within the scope of work. Slope protection for sides of filled up area and embankment in coal stack yard area as stated above. The type and extent of slope protection is shown in tender drawing (K9213-DWGR-S-0002).

  c) The entire work to be carried out in accordance with Technical Specification as given in Volume II G3/III.

  d) Removing the trees and bushes in the plant area will be in the scope of GSECL & grading work up to the finished grade level of the new plant, which is proposed to be at 72.00M above sea level will in the scope of bidder.

- Soil investigation for entire plant area including CHP and River intake pump house.
- Demolition of existing facilities/structures including underground structure/facilities including rerouting the same, if any and site clearance., for all except as indicated in list of exclusion.
- Demolition of existing track hopper and associated accessories and auxiliaries.

B. Power Block area

- Power house building including Control room, Turbo Generator foundation and other equipment foundation
- Boiler area foundations including Boiler, ESP, Fan foundations, Duct supporting columns and other foundations (Equipment and structural steel work for boiler and auxiliaries will be covered under mechanical sections).
- Mill Building including coal bunkers.
- Mill reject storage bins or silos.
- ESP Control Room.
- RCC Chimney (Steel lining).

C. Transformer yard

- Transformer yard foundations and substructure including Transformer foundations, Rail track, fire wall, common oil pits, electrical trenches, pull pits and duct bank, drainage, fencing and surfacing with gravel etc. all complete
- All other buildings and structures as per approved electrical layout.

D. Switchyard

- Switchyard structures, foundations, drains, pits, switchyard concrete roads, RCC cable trench, fencing and surfacing with gravels etc. all complete
- All other buildings and structures as per approved electrical layout.

E. Coal Handling system

- Wagon Tippler (2 nos) : The location of wagon tipplers shall be in line with the latest Plot Plan drawing (Drg. No. K9213R-DWG-M-002). The EPC contractor has to construct 2 nos of wagon tipplers as per the specified location.
- In motion weigh bridge on proposed track for unit # 8.
- RCC tunnel
- Transfer point.
- Pent house.
- Crusher house.
- Stacker/Reclaimer.
- Crushed Coal stock pile yard including paving and drainage system.
- Control room / MCC room for coal handling plant..
- All other buildings and structures as per approved mechanical layout.

F. Ash Handling system

- Bottom Ash Slurry pit and pump house
- Ash compressor building.
- Ash handling plant control room.
- Ash water pump house.
- Ash pipe corridor
- Fly Ash Silo with concrete approach road.
- All other buildings and structures as per approved mechanical layout.

G. Fuel oil System

- LDO/HFO Day Tank foundations and dykes.
- FO pressurizing pump house
- LDO/HFO pipe corridor.
- FO Transfer pump house
- All other buildings and structures as per approved mechanical layout.

H. Raw water supply and pretreatment system including Intake

- River Intake pump house, approach bridge and shore protection work. (Also refer Section 2.01.00 for River Intake Pump House and Approach Bridge)
- Pre-Treatment Plant
- Clarified water reservoir.
- Clarified water pump house.
- Chlorination Plant.
- Side stream filter.
- All other buildings and structures as per approved mechanical layout.

I. Demineralised water supply system

- DM Plant, DMW STG Tanks, Chem. House etc
- All other buildings and structures as per approved mechanical layout.

J. CCW system

- ND cooling tower.
- Cooling water pipes and return pipes upto inlet flange of cooling tower including their supports and foundations, thrust blocks etc. wherever required.
- CW pump house.

- All other buildings and structures as per approved mechanical layout.

K. Fire fighting system

- Clarified and Fire water reservoir
- Clarified & Fire water Pump house
- Fire Station Building
- All other buildings and structures as per approved mechanical layout.

L. Other Utility services and Non-plant Building

- Effluent Treatment plant.
- Pipe and Cable rack.
- Technical and Service Building with furniture of approved make.
- DG & Compressor Building.
- Stores comprising of 5 nos of store godowns, each of approximate size of 200 sqm, one store office of approximate size 100 sqm surrounded by brick masonry compound wall and one weigh bridge of minimum 40 MT capacity.
- HCSD Pump House.
- Canteen Building with furniture of approved make.
- Watch Tower (4 nos)
- Water Harvesting Well – to be provided with every building; Additional 10 (Ten) nos shall be provided in different area.
- Miscellaneous tank foundations and dykes.
- Yard Toilets – 2 nos (one in main plant and one in CHP)
- Owner's site office of 3500 sqft area.

M. Plant roads and drainage

- Roads, culvert & pavement within the battery limit of this specification and as shown in Plot Plan. The scope shall also include modification and diversion of existing roads, where necessary. Approach road for ETP area & Ash water Clarifier area.
- Storm water drain, plant drainage and outfall structure.
- Sanitary sewer including inspection pits, manholes etc. and treatment plant. STP by others.
- Plant roads will be of Reinforced Concrete rigid pavement in general.

N. Piling work for foundations and substructures, if necessary

O. Boundary walls / Fencing around any buildings/area, if required from statutory point of view.

P. Main plant paving including plinth protections around building and structures

Q. Slope protection for embankment including required filling work in plinth and plant area and RCC retaining wall along with pile wherever required.

R. Chain link/barbed wire fencing around unit #8 as per tender drawing K9213-DWG-S-0002R and wherever else required to be included..

S. Diversions of existing Boiler drain pipe line and laying the same as per specification given in Volume IIG/3 Section XXXI.

T. Construction of 6.5m wide RCC road from proposed Ash silo to existing Brick plant (approximately 1600M long) in between 800E and 450W.

U. All buildings, facilities, equipments for unit #8 to be located beyond 200m distance from Mahi River Bank as per MOEF requirements.

V. Architectural finishing including flooring, paving, cladding, masonry works, plastering, painting, false ceiling, doors & windows, plumbing, roof treatment, anti-termite treatment etc

W. The scope shall also include all necessary civil work (mainly civil foundation) pertaining to erection of stator/any other equipment (if required).

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project.

The Bidder shall visit the site and assess the involvement of demolition and site clearance, area grading if required, within the plant area to construct the project.

There is a nala towards North-East corner of the plot outside the plant boundary discharging into Mahi River. The proposed outfall structure for plant drainage shall be located at a suitable location on the discharge canal.

The work shall have to be carried out both below and above the ground level.

Additional site investigations, surveys, grading and leveling and other additional works shall be carried out by the Contractor, if necessary.

The layout and levels of all structures shall be made by the Contractor at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The Contractor shall be solely responsible for the correctness of the layout and levels.

All necessary statutory clearances shall be obtained by the Bidder prior to execution of work under scope of this specification.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to by the Contractor

2.01.00 **River Water Intake**

The river water intake pump house shall be on Mahi River at a location about 500 m from Plant Site. River water shall be drawn and supplied to Pump House inside plant boundary through pipe lines.

The contractor has to select the most suitable location of Intake structure and design the pump house together with water conveying system on the basis of flow of river e.g., highest and lowest water levels, discharge, river bed material, etc., its past characteristics and other parameters collected by him from concerned authorities for this work. The location of the pump house shall be governed by the maximum and minimum water depth at the river section to ensure supply of raw water throughout the year. The contractor has to submit river flow data and all other relevant information to establish his design.

The scope of work shall also include :

a) Surveying River Section, shore and pipe corridor upto plant for the above work. In river section cross sections shall be taken at right angles to the river and at 50M chainage. In every cross section the bed levels shall be taken at 10M intervals.

b) Carrying out Geotechnical investigation at river bed and shore for above work and obtain Hydraulic data for design of well and its foundation.

c) Underwater works for river bed protection around pump house, navigation aids and measures to guard water-borne structure against river-traffic.

d) Facilities on the bank such as electrical switchgear room, transformer foundations and miscellaneous associated civil works.

e) Provide and maintain safe approaches to pump house location from river bank, as necessary, to bring materials, labour, construction plants tools and machineries till successful completion of the work.

The proposed work shall be in line with approved construction drawings. Construction drawings showing complete nature of work shall be furnished to the Owner's Consultants progressively for approval during execution of the work

The materials removed from inside the well are to be disposed off in a manner and at locations as would be advised by Owner and this aspect is to be covered in the quoted price.

The work to be performed under this Contract consists of providing all labour, materials, scaffolding, construction equipment, tools & plants, supplies, transportation, all incidental items not shown or specified but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the approved drawings & technical specifications.

The scope of work shall also include executing of any temporary work for on-time and successful completion of entire work and removing the same after its completion.

2.02.00 **List of Exclusions**

a. New Railway Track for unit # 8

b. Dismantling and Rerouting of underground structures like Gravity Drain and waste water trench.

c. Security Gate, Security office, Time Office.

d. Sewage Treatment Plant

e. Dismantling and rerouting of 300mm dia M.S. pipe line and 400mm dia C.I. Pipe line from jack well to existing pump house and Stabilization pond no. 02 & 03

f. Green belt development

2.03.00 **Terminal Points**

Storm and Plant drainage	Upto Mahi River; Outfall structure to be constructed near existing drainage nala.
Plant Service Road	Existing Plant Road
Sanitary Facilities	Upto New Sewage Treatment Plant to be constructed by others.
Site Grading	Site Battery limits to final elevation.
Site Battery limit fencing	Site perimeter.

2.04.00 **Notes**

a) This section shall be read in conjunction with Lead Specification and General conditions of contract.

b) For Architectural requirements of the plant Volume IIG/2 shall be referred to.

c) In the event, any contradictions, confusion arises for any statement / condition / terms pertaining to design of civil engineering systems, stated elsewhere in addition to this section, the statement furnished in this section shall prevail.

d) In the event, the bidder notice any inadvertent error / mistake published in the specification, the same shall be immediately brought to notice of the Owner.

3.00.00 **CODES AND STANDARDS**

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/amendments, if any, shall be followed :

3.01.00 **General**

a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Works.

e) IS-1256 : Code of Practice for Building Byelaws.

3.01.01 Earthwork

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

3.01.02 Concrete

a) IS-269 : Ordinary and low heat portland cement.

b) IS-383 : Coarse and fine aggregate from natural sources for concrete.

c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

d) IS-455 : Portland Slag Cement.

e) IS-456 : Code of Practice for Plain and reinforced concrete.

f) IS-460 : Test Sieves (all parts).

g) IS-516 : Methods of test for strength of concrete.

h) IS-1199 : Methods of sampling and analysis of concrete.

i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.

k) IS-1834 : Hot applied sealing compounds for joints in concrete.

l) IS-2386 : Methods of test for aggregates for concrete (all parts).

m) IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.

n) IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).

o) IS-3414 : Code of practice for design and installation of joints in buildings.

p) IS-4948 : Welded steel wire fabrics for general use.

q) IS-6452 : High Alumina Cement for Structural use.

r) IS-7320 : Concrete slump test apparatus.

s) IS-7861 : Code of practice for extreme weather concreting (all parts).

t) IS-8041 : Rapid Hardening Portland Cement.

u) IS-8112 : High strength ordinary Portland Cement.

v) IS-10262 : Recommended guidelines for concrete mix design.

w) IS-12269 : 53 grade ordinary Portland Cement

3.01.03 Foundations

a) IS-1904 : Code of practice for structural safety of buildings : Shallow foundations.

b) IS-2950 : Code of practice for design and construction of raft foundations.

c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).

d) IS 2911 : Code of practice for Design and Construction of Pile Foundation.

3.01.04 Loading

a) IS-875 : Code of practice for Structural safety of buildings - loading standards.

b) : Bridge Rules of Government of India, Ministry of Railways (Railway Board).

3.01.05 Masonry

a) IS-712 : Building limes.

b) IS-1077 : Common Burnt Clay Building Bricks.

c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

d) IS-1528 : Methods of sampling and physical tests for refractory materials.

e) IS-1597 : Code of practice for construction of stone masonry (all parts).

f) IS-2212 : Code of practice for brickwork.

g) IS-2116 : Sand for masonry mortars

h) IS-2185 : Concrete masonry units.
(all parts - Hollow and Solid concrete blocks).

i) IS-2250 : Code of practice for preparation and use of masonry mortars.

j) IS-2572 : Code of practice for construction of hollow concrete block masonry.

k) IS-2691 : Burnt clay facing bricks.

l) IS-3414 : Code of practice for design and installation of joints in buildings.

m) IS-3495 : Methods of tests of burnt clay building bricks.

n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.

o) IS-4860 : Acid Resistant Bricks.

3.01.06 Doors, Windows and Ventilators

a) IS-399 : Classification of commercial timbers and their zonal distribution.

b) IS-883 : Code of practice for design of structural timber in building.

c) IS-1003 : Timber paneled and glazed shutters (all parts).

d) IS-1038 : Steel doors, windows and ventilators.

e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

f) IS-1361 : Steel windows for industrial buildings.

g) IS-2835 : Transparent sheet glass for glazing and framing purposes.

h)	IS-1948	:	Aluminium doors windows and ventilators.
i)	IS-1949	:	Aluminium windows for industrial building.
j)	IS-2191	:	Wooden flush door shutters (Cellular and hollow core type).
k)	IS-2202	:	Wooden flush door shutters (solid core type).
l)	IS-3103	:	Code of practice for Industrial ventilation.
m)	IS-3548	:	Code of practice for glazing in buildings.
n)	IS-3614	:	Fire check doors.
o)	IS-4021	:	Timber door, windows and ventilator frames.
p)	IS-4351	:	Steel door frames.
q)	IS-6248	:	Metal rolling shutters and rolling grills.

3.01.07 Roof and Flooring

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof.
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses.
c)	IS-2210	:	Criteria for Design of R.C. shell structures and folded plates.
d)	IS-809	:	Rubber flooring materials for general purposes.
e)	IS-1195	:	Bitumen mastic for flooring.
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring.
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors.
h)	IS-1237	:	Cement concrete flooring tiles.
i)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish.
k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring.
l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping.
m)	IS-5766	:	Code of practice for laying burnt clay brick flooring.

n) IS-1197 : Code of practice for laying of rubber floors.

o) IS-2441 : Code of practice for fixing ceiling coverings.

3.01.08 Waterproofing

a) IS-1322 : Bitumen felts for waterproofing and damp proofing.

b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.

c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.

d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.

e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.

h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

3.01.09 Soil Engineering

a) IS-1498 : Classification and identification of soils for general engineering purposes.

b) IS-1892 : Code of practice for sub-surface investigation for foundations.

c) IS-2131 : Method for standard penetration test for soils.

d) IS-2720 : Methods of test for soils (all parts).

3.01.10 Water Supply, Drainage and Sewerage

a) IS-404 : Lead pipes

b) IS-458 : Concrete pipes

c) IS-651 : Salt glazed stoneware pipes and fittings.

d) IS-771 : Glazed fire-clay sanitary appliances (all parts).

e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns.

f)	IS-783	:	Code of practice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200	:	Method of measurement: Laying of water and [Part-XVI] sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
s)	IS-3486	:	Cast iron spigot and socket drain pipes.
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
v)	IS-1538	:	Cast iron fittings for pressure pipes for water, gas and sewage.
w)	IS-1230	:	Cast iron rainwater pipes and fittings.
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y)	IS-784	:	Prestressed concrete pipes.
z)	IS-1726	:	Cast iron manhole covers and frames.
aa)	IS-5961	:	Cast iron grating for drainage purposes.

bb) IS-5219 [Part-I] : "P" and "S" traps.

cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.

dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.

ee) IS-777 : Glazed earthenware wall tiles.

ff) IS-2548 : Plastic water closet seats and covers (all parts).

gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

3.01.11 Paving and Road works

a) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220

d) Practice followed by Indian Road Congress (all parts).

3.01.12 Earthquake Resistant Design

a) IS-1893 : Criteria for earthquake resistant design of structures.

b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

3.01.13 Chimney

a) IS-4998 : Criteria for Design of R.C. Chimneys (all parts).

3.01.14 Structural Steelwork

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line.

Part-I : Load and permissible stresses.

Part-II : Fabrication, Galvanizing, Inspection & Packing.

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d) IS-808 : Rolled steel beams, channels and angle sections.

e)	IS-813	:	Scheme of symbols for welding.
f)	IS-814	:	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g)	IS-816	:	Code of practice for use of metal arc welding for general construction in mild steel.
h)	IS-817	:	Code of practice for training and testing of metal arc welders.
i)	IS-818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j)	IS-819	:	Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k)	IS-919	:	Recommendations for limits and fits for engineering.
l)	IS-1024	:	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m)	IS-1161	:	Steel tubes for structural purposes.
n)	IS-1182	:	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o)	IS-1200 [Part-VIII]	:	Method of measurement of steelwork and ironwork.
p)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
r)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
s)	IS-1365	:	Slotted counter sunk head screws (dia. range 1.6 to 20 mm).
t)	IS-1367	:	Technical supply conditions for threaded steel fasteners.
u)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	:	Method for tensile testing of steel products.
w)	IS-1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.

x) IS-1731 : Dimensions for steel flats for structural and general engineering purposes.

y) IS-1852 : Rolling and cutting tolerances for hot rolled steel products.

z) IS-1977 : Structural steel (Ordinary quality)

aa) IS-2016 : Plain Washers

bb) IS-2062 : Steel for General structural purposes.

cc) IS-2074 : Ready mixed paint, air drying, red oxide zinc-chrome, priming.

dd) IS-2633 : Methods of testing uniformity of coating of zinc coated articles.

ee) IS-3613 : Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.

ff) IS-3664 : Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.

gg) IS-3757 : High strength structural bolts.

hh) IS-4000 : High strength bolts in steel structures.

ii) IS-4759 : Hot dip zinc coatings on structural steel and other allied products.

jj) IS-5334 : Code of practice for Magnetic Particle Flaw detection of welds.

kk) IS-7215 : Tolerances for fabrication of steel structures.

ll) IS-7280 : Base-wire electrodes for sub-merged arc welding of structural steels.

mm) IS-7318 [Part-I] : Approval test for welders when welding procedure approval is not required.

nn) IS-8500 : Structural steel - microalloyed (medium and high strength qualities).

oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.

pp) AWS D.1.1 Structural Welding Code.

3.01.15 Painting

a) IS-348 : Specification for French Polish.

b) IS-427 : Specification for Distemper, dry colour as required.

c) IS-428 : Specification for Distemper, oil emulsion, colour as required.

d) IS-1477 [I & II] : Code of practice for painting of ferrous metal in buildings.

e) IS-2338 [I & II] : Code of practice for finishing of wood and wood based materials.

f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

3.01.16 a) Indian Road Congress (IRC) Bridge Codes

b) Indian Railway Standard Bridge Rules

3.01.17 Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

4.00.00 UNITS AND LANGUAGE

4.01.00 Drawings

- All dimensions will be in SI Units - Metric (English)
- Scales
  - Planning Drawings: Site Layout & Elevations will be at 1:500, Section & Elevation of each building will be at 1:200.
  - Structural and architectural Plans, sections, and elevations will generally be at 1:100 and/or 1:50; for architectural and civil details; 1:1, 1:5, 1:10, 1:20 as required will be used.
  - Site work and yard piping plans will generally be at 1:200, 1:500
- Text will be in English language

4.02.00 **Units for Calculations**

All calculations will be in SI (English) units.

Length	mm, M
Area	mm^2, M^2
Volume (solids)	mm^3, M^3
Volume (liquids)	mm^3, M^3, liter
Density	kN/M^3
Force	N, kN
Pressure (piping)	Bar
Moment	kNM
Stress	Mpa, N/mm^2
Distributed loads, ground pressures, etc.	kN/M^2

English language will be used in calculations

5.00.00 **GENERAL SITE INFORMATION**

The plant will be located inside the existing Wanakbori Thermal Power Station Complex.

The existing Wanakbori Thermal Power Plant has seven (7) nos. 210 MW units. One 800 MW supercritical unit will be installed for augmentation of total plant capacity.

On the north-eastern side of the existing plant adjacent to river Mahi, GSECL has land for the new construction. This land is unused and covered with trees and bushes. The average level of the land is approximately at 64 M above Mean Sea Level (MSL). This is below the design flood level, which is at 69.92M above MSL. The Finish grade level of the existing plant is at 78 M above MSL.

Removing the trees and bushes in the new plant area will be in the scope of GSECL. However if changes in the project is done by EPC Contractor, then tree cutting for additional area shall be in EPC Contractor scope.

Grading work upto the finish grade level, which is proposed to be at 72.0M above MSL, will be in the scope of bidder.

Meteorological Data	
Site Conditions :	
Maximum Ambient Dry Bulb Temp./Relative Humidity	40.8^oC/81.5%
Minimum Ambient Dry Bulb Temp./Relative Humidity	10.8^oC/42.5%
Average Barometric Pressure	1012 mbar
Location	North-eastern side of Wanakbori Thermal Power Station, adjacent to river Mahi.

Design Flood Level	70 M above MSL
Seismic Criteria	III
Wind Design	Basic Wind Speed, Vb = 39m/s
Average Annual Rainfall	750 mm
Rainfall Intensity Rates :	
Rainfall Intensity per Hour for Storm Water Drainage Design	90mm/hr for design purpose
Ground Snow Load	Nil

6.00.00 SITE DEVELOPMENT AND DRAINAGE

6.01.00 Plant Coordinate System

- The site will be surveyed and coordinates for all points determined
- The surveying contractor will establish plant benchmarks and North/South and East/West control lines for control of construction on the plant site. The North/South and East/West control lines will be developed based on grid systems of the existing Plant.
- To facilitate design and construction, a plant grid system and plant north will be established. The plant coordinate system will be laid out based on this grid.
- The plant coordinate system will be indicated on the Plot Plan Drawing.

6.02.00 Grading

All plant levels referred as RL will be with respect to Mean Sea Level (MSL) and all plant elevations referred as EL will be with respect to Power House Building Ground Floor elevation as 0.0M which will be equal to RL 72.30M. The site bench mark will be established by the contractor accordingly.

- Plant grading that may be required will be done considering existing site conditions. Accordingly, the finished grade level of this plant will be kept at RL 72.00 M.
- The road levels will be at 72.15 M.
- The finish floor level of ground floor of all the buildings will be at RL 72.3M.
- The top of grout (under side of equipment base/base plate) for foundations and structures outside building at grade will generally be 200 mm above finished grade. The top of grout (under side of equipment base/base plate) for all equipment foundation at ground floor within the building will generally be 150mm above finished floor unless dictated otherwise by mechanical / electrical system layout.
- Base plates for structural steel building columns will generally be 1250 mm below ground floor in order to keep enlarge portion of gusseted

base below ground. This portion shall be encased in concrete for corrosion protection.

6.03.00 **Drainage**

6.03.01 General

The plant will be provided with gravity drainage systems for the followings:

- Storm water Drainage
- Plant Drainage including Oily Water/ equipment process/chemical waste water
- Sanitary waste/ Foul water Drainage

6.03.02 Storm Water Drainage System

Storm water runoff is runoff from plant areas not subjected to contamination and will be discharged to terminal point via new lifting station if required any. Examples of such areas include building roofs, roads, paved areas, stone surfaced areas, grass surfaced areas, and other natural surfaced areas.

Storm water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins, manholes and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

For buildings that have a gutter and downspout system, the downspouts will empty to gullies or inspection chambers with sand trap at ground level before discharge to the main drainage system. Drainage from Basements, Cable and pipe trenches will be routed to sumps and connected to the storm water drainage system by pumping system.

The storm drainage system will be designed for maximum rainfall intensity of 90 mm/hour.

For pitched roof with metal sheeting a minimum slope of 1 (V) to 5 (H) and for flat roof a minimum slope of 1(V) to 50 (H) will be provided for efficient drainage of rain water.

The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron pipes will be used below buildings and HDPE pipes will be used for below grade piping drainage system. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.03 Plant Drainage System

Oily waste water will pass thru oil water interceptor and then combined with storm water drainage system for ultimately discharged to terminal point. Oily

waste water will include surface run off from transformer compounds, building floors and drains from other oil contaminated areas

Oily waste water will be collected via a surface drainage system consisting of open drains, gulley pits or catch basins and below grade pipe system to terminal points. In general, any surface drainage will be designed so that vehicles and equipment can drive over the finished surface.

The contaminated surface water runoff from rain will be designed for maximum hourly rainfall intensity.

The drainage from transformer pit will be stored in a collecting tank and subsequently passed through oil water interceptor before connecting to the storm water drainage system.

The maximum velocity for pipe drains and open drains will be limited to 2.4 M/sec and 1.8 M/sec respectively. However, minimum velocity for self cleansing of 0.6 M/sec will be ensured. Bed slope will not be milder than 1 in 500.

Cast iron oily pipes will be used below buildings and ductile iron cement lined oily line will be used outdoors. Manhole will be provided at every 50 M interval, at connection points and at change of alignment.

6.03.04 Sanitary Waste Sewer / Foul Water Drainage System

The sanitary waste/ foul water will be discharged to gravity fed foul manhole and then to a sewage treatment plant.

HDPE pipes shall be used for drainage. Sewers will be designed for a minimum self-cleansing velocity of 0.70 m/sec and the maximum velocity will not exceed 2.4 m/sec.

Manhole will be provided at every 50 meter along the length, at connection points and at every change of alignment, gradient or diameter of sewer pipeline.

The slope of sanitary pipe within the buildings will equal 20 mm per meter (1:50). Piping outside the buildings will be designed to maintain a minimum self-cleansing velocity with slopes not milder than 1 in 500.

6.04.00 **Roads**

- All new roads, hardstands will be provided to have accessibility to the plant where required and to be connected with the existing station road network at suitable points.
- The width of all roads will be 7.5M in general except for minor roads which will be 4.0 M.
- Roads will be constructed between raised kerbs and graded to falls leading surface water into catch pits connected to drainage system.
- The roads will be of reinforced concrete rigid pavement in general.

- Roads will be designed for axle load as per IRC recommendation.
- At corners and road intersections within the plant, the minimum radius of turn will be 15.00 M where possible for all class of roads
- Maximum grade will be 5%
- Minimum cross slope will be 2%
- Minimum overhead clearance will be 7.00 M

6.04.01 Pavement/Footpaths in Other areas

Paving as required will be provided using interlocking rubber moulded pre-cast concrete block having M25 grade concrete and minimum 80mm thickness.

6.05.00 **Fencing**

Chain link fencing with gate will be provided around site. 2.4M high galvanized chain link fence with gate shall be provided around all stores and other fenced area and equipments as required.

Transformer compounds will have 2.4M high removable screen type fencing with gate made up of galvanized M.S. bar similar to existing plant.

6.06.00 **Electrical Conduit Protection**

All electrical conduits (duct bank) laid under ground will be encased in concrete. Reinforcements will be provided in the encased concrete at main traffic crossings and other areas requiring access during construction based on the final design and the Construction Sequence.

6.07.00 **Pipe and Electrical Concrete Trenches**

Generally pipe or electrical cables will be taken through concrete trenches with precast concrete covers. The trench covers will be designed for appropriate ground surcharge and vehicle load where necessary.

Generally all cableways outside building will be either thru concrete underground duct banks housing PVC pipes or overhead on pipe rack except for HV cables which will be through trench. However, any trenches located outside buildings will project 150 mm above the finished formation level to avoid ingress of storm water. The bottom of trench will be sloped suitably for draining out the collected water into sump pit.

6.08.00 **Electrical Manholes**

Cast-in-place, reinforced concrete manholes will be provided as required to meet the electrical system construction requirements.

Drainage sumps will be included in all manholes to improve ability to remove water from manholes. The use of portable pumps to remove water from manholes will be considered.

7.00.00 GEO-TECHNICAL CRITERIA

7.01.00 General Description of Soils

Will be as per Geo-Technical Report.

Boring and subsurface data regarding nature of soil, subsoil water etc. shown on drawings or otherwise furnished to the Bidder shall be taken as guidance only. The bidder shall satisfy himself of the character and volume of work under the items and expected surface and/or subsoil water to be encountered. He must satisfy himself about general conditions of the site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out work under this scope. The information and data provided herein are for general guidance only and any variation there from shall not affect the terms of the contract. The Owner shall not assume any responsibility for any deduction, conclusion or interpretation made from the above information and data. [Preliminary Soil report to be furnished by GSECL]

7.02.00 Ground Water and Dewatering Requirements

As per Geo-Technical Report.

7.03.00 Excavation Criteria including De-watering

Unless otherwise specifically mentioned in geo-technical report this shall be followed.

Excavation shall be carried out in all types of soil including soft soil, soft moorum, hard moorum, soft rock, hard rock etc.

After excavating to the founding level, the exposed sub-grade will be inspected and proof rolled, if required, prior to placing lean concrete for subsequent placing of rebar, setting forms and placing concrete. Soft or yielding areas will be excavated and replaced with compacted backfill. Bearing grades will be cleaned and kept dry prior to placing concrete.

Excavations will be maintained and protected against earth collapse from natural causes or subsequent construction work and will have stable slopes, as appropriate, to meet local soft conditions and safety codes.

7.04.00 Backfill Criteria

Site-excavated material free from unsuitable material may be used as backfill against pit and sump walls and as structural fill beneath foundations if suitable.

Off-site material if required to be used for backfill, it will be fully tested and installed as per the project specifications.

7.05.00 Compaction Criteria

Fill and backfill material will be as recommended in the Geo-technical Report and as required by project specification requirements.

Material used as structural fill (load bearing) beneath structures and roads will be compacted to a minimum of 95% of the maximum dry density (modified Proctor). Natural moisture content of material will not deviate more than 2 percent of optimum.

Material used as backfill (non load bearing) around structures will be compacted to a minimum of 90% proctor density. Natural moisture content of material will not deviate more than 3 percent of optimum.

7.06.00 **Foundation System**

Following foundation systems will be adopted as per details of subsoil strata and recommendations given in geophysical survey and soil report .

a) Foundations resting on Piles

Steam Turbine building including steam turbine foundation, Boiler area Foundation, Stack foundations, Main & Aux. Transformer Foundations, main steam pipe rack structure, Cooling tower and all other buildings and major structures will have piled foundations.

b) Foundations resting on virgin soil

Foundations for other miscellaneous outdoor equipments and structures will be under this category. All such foundations shall rest on virgin soil. The allowable bearing capacity for foundations supporting on this soil will be taken as per geo-technical report. The minimum depth of foundation to virgin soil (silty sand/silty clay) will be 1.0 meter unless specified otherwise in geo-technical investigation and recommendation.

All excavated formation to receive foundation will be checked by an experienced Geotechnical engineer to ensure uniformity and suitability for the founding medium. Any suspect material, whether made ground or weak virgin soil, will be removed and replaced by PCC.

The foundation of storage tank will be supported on RCC ring beam foundation. The area inside ring beam will have compacted sand fill with a sand-bitumen layer on top.

c) Foundations resting on fill material

All grade slab, trenches, pits, electrical trenches & duct banks, manholes and other lightly loaded equipments & structures with bearing pressure not exceeding 50kN/Sq.M will be founded on this founding medium. A minimum of 0.5M below foundation will be of compacted sub-grade to a min. of 95% of the max. dry density (modified Proctor).

All excavated formation below sub-grade will be checked by an experienced Geotechnical engineer to ensure uniformity and suitability for the founding medium. Any suspect material, whether made ground or weak virgin soil, will be removed and replaced by PCC.

7.06.01 Allowable Settlement of Foundations

The following are the permissible limit of total settlement and differential settlement values which will be considered for design of equipment and building foundations unless more stringent criteria specified by the equipment supplier.

Item	Settlement Criteria
Steam Turbine Foundation	Maximum total long term vertical settlement after interconnecting systems are complete and the unit is placed in operation shall not exceed 25mm or limit specified by equipment manufacturer.
Boiler area foundations and Stack foundations	1. The allowable overall settlement of foundation will not exceed 25mm/ vendor requirements
	2. Max allowable differential settlement of foundation will not exceed 12.5mm./ vendor requirements
Transformer foundation (including oil fill)	1. The allowable overall settlement of foundation will not exceed 25mm / vendor requirements.
	2. Any additional long-term settlements after bus duct connections are made and transformer placed in service should not exceed 50mm
Turbine Building foundations	1. The allowable overall settlement of foundation will not exceed 25mm. 2. Max allowable differential settlement of foundation will not exceed 12.5mm.
Other building and Structures foundations.	1. The allowable overall settlement of foundation will not exceed 25mm. 2. Max allowable differential settlement of foundation will not exceed 12.5mm.
Miscellaneous Electrical Equipment foundations.	1. The allowable overall settlement of foundation will not exceed 25mm.
Misc. Mechanical Equipment • Boiler Feed Pump • Lube Oil Skid • Other major equipments	The allowable overall settlement of foundation will not exceed 25mm.
Flat Bottom above Ground Storage Tanks	1. Uniform Settlement : • Vertical settlement after filling, hydro-test will not exceed 25mm.at perimeter unless flexible shell nozzle connections used. 2. Differential Settlement of Center with respect to Edge • The center of the bottom plate floor will not exceed the settlement of the edge by more than diameter/90.

7.06.02 Minimum Founding Depth

The bottom of foundations on virgin soil will not be less than 1.0 meter from finish grade level unless specified otherwise in geo-technical investigation and recommendation. Foundations for Misc. Skids and other minor supports will be kept minimum 300 mm below finished grade unless greater depth is required by site specific requirements.

8.00.00 **LOADS**

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. Any structure which carries Indian Railway Loading or is situated in the vicinity of Railway Lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc. All structures and foundations shall be designed for most critical combinations of dead load, live load, equipment load, pipe and cable tray loads, crane loads, wind loads, seismic loads, temperature loads and special loads as applicable as per requirement of relevant codes and standard.

A) Dead Loads

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, silo, bins and hoppers shall be measured at full capacity for this purpose. Hung loads and the contents of tanks, silo, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials		**Unit weight**
Plain cement concrete	:	24.0 kN/cum
Reinforced cement concrete	:	25.0 kN /cum
Structural steel	:	78.5 kN /cum
Brick work	:	19.0 kN /cum
Cement plaster	:	21.0 kN /cum
Floor Finish, screed concrete, Plaster	:	24.0 kN /cum
Steel grating floor	:	0.5 kN/sq.m
Checkered plate cover	:	0.5 kN/sq.m

Materials		Unit weight
False floor	:	1.0 kN/sq.m
False ceiling in control and Electric rooms	:	0.4 kN/sq.m
Metal decking	:	0.15 kN/sq.m
Insulated metal siding	:	0.25 kN/sq.m
Non insulated metal siding	:	0.15 kN/sq.m
Masonry unit with plaster on both sides :		
230 mm nominal thickness	:	4.95 kN/sq.m
115 mm nominal thickness	:	2.47 kN/sq.m
Coal	:	12.0 kN /cum
Fly Ash	:	16.0 kN /cum
Bottom Ash	:	16.0 kN /cum

B) Live Loads

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary. Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) All Buildings

a) Roofs :

Inaccessible roof	:	0.075 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof where equipments are placed	:	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof without equipments	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).

	b)	Stairs & Platforms	:	5.0 kN/Sq.m
	c)	Corrridors	:	5.0 kN/Sq.m
	d)	Removable gratings, chequered plates, walkways etc.	:	5.0 kN/Sq.m (for supporting beams) 7.0 kN/Sq.m (for grating/chequered plate)
	e)	Office, Laboratory, Conference rooms and other non-plant areas etc.	:	5.0 kN/Sq.m
ii)	Power House Building			
	a)	Ground Floor		
		Unloading Bay	:	50 kN/Sq.m
		Other areas	:	20 kN/Sq.m
	b)	Mezzanine Floor	:	15 kN/Sq.m plus hung loads.
	c)	Operating Floor		
		T.G. Lay-down Area	:	35 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher
		Other Areas in Turbine Hall	:	25 kN/Sq.m plus hung loads
			:	Rotor removal area beams shall also be checked for half the rotor load at the center of the beam
		Other Areas in Operating Floor	:	15 kN/Sq.m plus hung loads
	d)	Cable Spreader Floor	:	7.5 kN/Sq.m plus hung loads
	e)	All other floors	:	15 kN/Sq.m plus hung loads
	f)	Due to anchoring of conductors on "A" row column	:	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Sheilding Wires) OR actual load furnished by equipment supplier

iii) Mill Building

a)	Ground Floor	:	25 kN/Sq.m
b)	Feeder Floor	:	15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
c)	Tripper Floor	:	10 kN/Sq.m + hung loads + 0.5 KN/Sq.m (dust load).

iv) Auxiliary Buildings

a)	Ground Floor	:	10 kN/Sq.m
b)	Cable Spreader Floor	:	7.5 kN/Sq.m
c)	Pump House Operating Floor	:	10 kN/Sq.m
d)	Office Floor	:	5 kN/Sq.m
e)	Switchgear room	:	15 kN/Sq.m
f)	All other Floors	:	10 kN/Sq.m

v) Non Plant Buildings

a)	Floors with equipment	:	10 kN/Sq.m
b)	All other floors	:	5 kN/Sq.m

vi) Underground Structures/Trenches/pits

Minimum surcharge shall be 10 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement, 20 kN/Sq.m surcharge shall be considered. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 10 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

vii) Covers for Trenches

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall be considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards.

viii) Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

ix) Road Culverts

Road culverts shall be designed for Class `AA' loading (wheeled and tracked both) & to be checked for Class `A' loading as per IRC standards.

x) Reduction in Live Load

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, will be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor from floors below.

C) Equipment Loads

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air & gas duct loadings will include weight of insulation, duct attach-ments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

D) Wind Loading

Wind loading will be in accordance with Indian Standard Code IS:875 (Part 3) for a basic wind speed of 39 m/s upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

E) Seismic Loading

The lateral forces will be established in accordance with the recommendations of IS:1893 (Latest Version only). The site falls in Zone-III as identified in the map in IS:1893-2002. Importance factor shall be taken in accordance with IS:1893-2002, Part-IV.

F) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Mean Daily minimum ambient temperature during coldest month of the year = 10.8° C

Mean Daily maximum ambient temperature during hottest month of the year = 40.8° C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

G) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

H) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of sub-structure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

I) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows:

Crane loads :

a) For vertical force, an impact factor of 25% of the maximum crane wheel load

b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail

c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

a) Impact factor of 10% of lifted load of hoist for monorail and support design

b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

J) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing so far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented by bidder to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

K) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

L) Thrust Load

Thrust blocks will be designed against the thrust load from pipe lines considering the test pressure in the pipe lines.

M) Ash Silo

The following densities shall be considered for design of coal bunkers

a)	For volume calculation of bottom ash silo	:	6.5 kN/cum
b)	For volume calculation of fly ash silo	:	7.5 kN/cum
c)	For load calculation of both types of silos	:	16.0 kN/cum

The ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be considered in design.

8.01.00 **Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits, trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the

superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS codes However, following minimum factor of safety shall be followed.

a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

b) Factor of safety against sliding shall be 1.5 minimum.

c) Factor of safety against uplift due to hydrostatic forces shall be 1.25 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered as per Final Geotechnical Investigation Report for design of foundations and all underground structures.

9.00.00 LOADING COMBINATIONS

Buildings and structures, will be designed to resist the load stated in the previous section and the worst combinations of the basic load cases stated below. The combinations stated here are the minimum load combinations to be considered in design. The contractor is to establish all the possible load combinations which may arise during the life of the structure. The structural adequacy and serviceability shall be checked accordingly.

9.01.00 Basic Load Cases

1.	DLS	[Only self weight]
2.	DLE	[Self weight of equipment]
3.	LLR	[Roof live load]
4.	LLF	[Floor live load]
5.	CL-L+CLHx(+)	[Maxm. Crane load on left col. plus horizontal surge in (+) X-direction]
6.	CL-L+CLHx(-)	[Maxm. Crane load on left col. plus horizontal surge in (-) X-direction]

7.	CL-R+CLHx(+)	[Maxm. Crane load on right col. plus horizontal surge in (+) X-direction]
8.	CL-R+CLHx(-)	[Maxm. Crane load on right col. plus horizontal surge in (-) X-direction]
9.	WLx(+)	[Wind load in (+) X-direction]
10.	WLx(-)	[Wind load in (-) X-direction]
11.	WLY	[Wind load in (+) Y-direction)
12.	SLx	[Seismic load in (+) X-direction]
13.	SLy	[Seismic load in (+) Y-direction]
14.	CL	[Crane self weight]
15.	TL	[Temperature load]
16.	CLI-L+CLIHx(+)	[Maximum crane load on left col with 50% lifting wt. Plus horizontal surge in (+) X-direction]
17.	CLI-L+CL1Hx(-)	[Maximum crane load on left col. with 50% lifting wt. Plus horizontal surge in (-) X-direction]
18.	CLI-R+CLIHx(+)	[Maximum crane load on right col. with 50% lifting wt. Plus horizontal surge in (+) X-direction]
19.	CLI-R+CLIHx(-)	[Maximum crane load on right col. with 50% lifting wt. Plus horizontal surge in (-) X-direction]

Note:
(X-direction is towards the cross direction of the building from left to right).

9.02.00 **Load Combination for Steel & RCC Structure**

Comb	1 = 1 2 = 0.9(1) + 9 3 = 0.9(1) + 10 4 = 0.9(1) ± 11 5 = 0.9(1) + 12 6 = 0.9(1) – 12 7 = 0.9(1) ± 13	For anchor bolt and uplift of foundation
Comb	8 = [(1+2)+(3+4)+16+9] 9 = [(1+2)+(3+4)+17+10] 10 = [(1+2)+(3+4)+18+9] 11 = [(1+2)+(3+4)+19+10] 12 = [(1+2)+(3+4)+5] 13 = [(1+2)+(3+4)+6] 14 = [(1+2)+(3+4)+7] 15 = [(1+2)+(3+4)+8] 16 = [(1+2)+0.5(4)+14+12]	For super structure & foundation

17 = [(1+2)+0.5(4)+14-12]	
18 = [(1+2)+0.5(4)+14±13]	
19 = [(1+2)+(3+4)]	
20 = [(1+2)+0.5(4)+14]	For super structure & foundation
21 = [(1+2)+(3+4)+5+0.5(9)]	
22 = [(1+2)+(3+4)+6+0.5(10)]	
23 = [(1+2)+(3+4)+7+0.5(9)]	
24 = [(1+2)+(3+4)+8+0.5(10)]	

Load combinations for individual building will be taken suitably from above load combination.

For structure with no crane but monorail hoist the loading from monorail hoist will be included in live load case.

Note:

Temperature Loads (15) will be added with all above load combination.

Appropriate allowable increase in permissible stresses as per IS codes, may be taken.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS 456.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other underground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of sump pumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS : 3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

10.00.00 BUILDING DESIGN CONCEPT

10.01.00 Framing System and Method of Analysis

Analytical model of the building structure will be either two dimensional or a three dimensional space frame. Analysis of models shall be done using STAAD Pro Software.

For Steel frame structure, it will be either (1) Simple frames with vertical diagonal bracings at column lines in both directions and horizontal bracing at the roof and major floor levels or (2) Moment resisting frame in transverse direction with braced frames in longitudinal direction. For Concrete frame structure, it will be Moment resisting frame in both directions.

For composite framed building moment resisting frame will be provided in transverse and longitudinal direction with reinforced concrete columns and steel roof truss/girder framing members in transverse direction and reinforced concrete framing members in longitudinal direction.

10.02.00 Method of Design

The Strength design of Steel members will be done by allowable stress method using IS:800 (Latest Edition) where as the Strength design of Concrete members will be done by limit state method using IS:456 (Latest Edition).

Un-braced lengths for steel beams will be as per code or as determined from following criteria

- Beams supporting concrete slab with shear connectors will be considered continuously supported.
- Beams supporting metal roof deck attached with welding washers plug welded will be considered continuously supported.
- Beams supporting metal deck or concrete slabs formed with metal decking will have an un-braced length based on framing member locations.
- Beams supporting grating floor will be considered continuously unsupported.
- Beams which are part of a truss will use the distance between panel points as their un-braced length or, if the panel has connecting major members, the un-braced length will be based on the distance between panel points or connecting members, whichever is the shorter distance.
- In grating floor, for two parallel, interconnected beams, the beam with greater load will be considered as un-braced and the other beam as braced at the points of interconnection
- In grating floor, for three or more parallel, interconnected beams with loads of same order or magnitude, all beams will be considered as braced at points of intersections. When the beams are loaded

disproportionately, the un-braced lengths will be determined as stated above.

10.03.00 **Acceptance Criteria**

10.03.01 Structural system and Foundations

All buildings will be of framed structures. Foundations for all buildings will be piled/spread/raft footings resting on soil as stated in Section 12 except ground floor slab of all buildings which will be resting on grades.

10.03.02 Member Strength

As per IS:800 for steel members and as per IS:456 for concrete members.

10.03.03 Member Stiffness

As per IS 800 for steel members and as per IS:456 for concrete members except as noted here in after.

- Required Depth
  - For steel members, minimum depth equals to 1/24 of span unless clearance requirements will dictate lower depth in certain areas.
  - For Concrete members, minimum depth equals to 1/16 of span unless clearance requirements will dictate lower depth in certain areas.
  - Members will be framed into members of equal or greater depth
- Maximum deflections – As per Table 6 of latest edition of IS 800.

10.03.04 Foundation

Maximum Allowable Pile Load or Allowable Soil Bearing Pressure will be as per Geotechnical Investigation Report. The Foundation settlement will be limited to the allowable settlements as specified for different systems and equipments.

10.03.05 Dynamic Criteria

For Foundations of rotating major equipments, the natural frequency and allowable vibrating amplitude/velocity will be as per criteria furnished by the Vendor. In absence of such criteria, the foundation will satisfy the criteria set forth in IS 2974, DIN 4024 and VDI 2056.

For the foundations supporting minor equipments weighing less than 10 kN or if the mass of the rotating part is less than one-hundredth of mass of the foundation, no dynamic analysis will be carried out.

A. Steam Turbine Generator Foundation Design Criteria

The Steam Turbine Generator shall be rigid RCC frame structure supported on pile foundations. The concrete outline and embedments/ inserts/pockets detail shall be supplied by machine manufacturer.

Detailed static and dynamic analysis shall be performed both for normal operating condition & abnormal condition such as short-circuit, accidental loss of blades & earthquake. At any event of time any two transient loading (short circuit, seismic) need not be assumed to act in the same direction simultaneously. Seismic analysis shall be done by response spectrum method.

The dynamic analysis shall consist of free-vibration and forced vibration analysis. Frequency separation criteria and amplitude criteria as laid down in IS-2974 and or VDI 2056 and/or as required by machine manufacturer whichever is more stringent shall be satisfied.

Elaborate mathematical model shall be considered. Due regard shall be given to pile stiffness in lateral and vertical direction and pile-soil interaction.

Stress for thermal load, shrinkage and creep shall be properly accounted for. Minimum reinforcement shall be governed by IS-2974 as well as IS-456.

For appropriate load combinations or any other information, stipulations of IS-2974 shall be satisfied.

B. Boiler Feed Pump Foundation

This is generally a RCC block foundation resting on pile. It shall be isolated from the building to reduce the transmission of vibration. Concrete outline and details of pipe sleeves/pockets/embedments shall conform to the data provided by machine manufacturer. The mass of the RCC block shall not be less than three times the mass of the machine. All block foundations resting on piles shall be designed using elastic half space theory.

Dynamic analysis shall be carried out to calculate natural frequencies in all possible modes. Frequency and amplitude criteria shall be as per relevant IS codes/or VDI and/or as per requirements of machine manufacturer.

11.00.00 STRUCTURAL MATERIALS

Following materials will be used in design and construction of the structure and foundation:

11.01.00 Structural Steel

Designation of Structural Steel	Minimum Yield Strength
IS 2062	250 N/mm^2

11.01.01 Rolled Joists, Tee, Channel and Angle conforming to IS 2062 (Grade A).

11.01.02 Structural pipes conforming to IS 806 (YST 25)

11.01.03 Structural hollow sections (square & rectangular) conforming to IS:4923

11.01.04 Pipes of hand rail conforming to IS:1161 (Medium class Grade YST=240)

11.01.05 Plates, Flats, Ordinary steel washers conforming to IS:2062 (Grade A, B & C).

11.01.06 Steel Gratings – Carbon steel conforming to IS:2062.

11.01.07 Checkered Plates (6 mm thick) – Carbon steel conforming to IS:3502.

11.01.08 Anchor Bolts, Studs or Threaded Bars – Mild Steel of grade 4.6 conforming to IS:5624.

11.01.09 Connection Bolts – All High strength connection Bolts shall be of grade 8.8 conforming to IS:1367 and shall be supplied conforming to IS:3757. All mild steel connection bolts shall be of grade 4.6 conforming to IS:1367.

11.01.10 All nuts shall be of heavy duty hexagonal type and shall be compatible with the bolts.

11.01.11 All nuts & washers for high strength bolts shall conform to IS:6623 & IS:6649 respectively.

11.01.12 Washers for mild steel bolts shall be of mild steel conforming to IS:5369/IS:5372 or IS:5374 as the case may be.

11.01.13 Welding Electrodes – Low Hydrogen electrodes conforming to IS:814.

11.02.00 **Concrete**

11.02.01 Cement

All cement will be of Ordinary Portland quality conforming to IS:8112 (43 grade) / IS 12269 (53 grade). Fly ash based cement can be used for non structural concrete work.

11.02.02 Leveling Concrete

All non structural concrete used for leveling, filling, blinding layer etc. shall be 1:3:6 nominal mix.

11.02.03 Structural Concrete

Grade of structural concrete shall not be less than M25 grade unless stated otherwise.

- All structural concrete in contact with soil shall be of grade M25.
- All structural concrete for duct bank and pavements shall be of grade M20.

11.03.00 **Concrete Reinforcing Steel**

11.03.01 Material

All Reinforcing steel for concrete shall be high strength deformed TMT bars (fy = 500 N/MM2) conforming to IS:1786.

11.03.02 Concrete Cover

Following minimum clear concrete cover to steel reinforcement will be provided.

A.	**Substructure Works**	Bottom	Sides	Top	Ends
i)	Foundation	75	50	50	50
ii)	Columns, Pedestals, Grade Beams/Tie Beam	50	50	50	50
iii)	Trenches, Pits, Walls, Duct Bank etc. in contact with				
	Earth	50	50	50	50
	Water	50	50	50	50
	Others	25	25	25	40
iv)	Equipment Foundations	50	50	50	50
v)	Slab on Grade	25	50	25	50
B.	**Super structure Works**				
i)	Columns	-	40	-	-
ii)	Beams	35	35	35	50
iii)	Slabs/Walls	20	20	20	40
iv)	Lintel, Chajja, Bands etc.	20	20	20	25
v)	Pre-cast Concrete	20	20	20	20

12.00.00 **GENERAL DESCRIPTION**

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
1.	Power House Building						Structural Steel	RCC pile cap on pile	RCC (metal deck form over TG Hall)	RCC	For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01.
2.	Turbo Generator foundation, Boiler Feed Pump Foundation and all other major equipment foundations						RCC	RCC foundation on pile			
3.	Boiler Foundation						RCC	RCC pile cap on pile			
4.	ESP & Duct Supporting Foundation						RCC	RCC pile cap on pile			
5.	ESP Control Room						RCC	RCC pile cap on pile	RCC	RCC	For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01.
6.	RCC Chimney & Foundation						RCC	RCC Foundation on pile			
7.	Transformer Yard Foundations including Oil Pits						RCC	RCC Foundation on pile / RCC Trench			
8.	Switchyard Structures, Foundation & Trenches						RCC/ Structural Steel	Pile Foundation			For details refer K9213-EPC-SPC-001-IIG/2 section 3.03.01 .

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
9.	Switchyard Control Room Building						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
10.	DM Plant, DMW STG. Tanks, Chemical House etc.						RCC	Pile Foundation	RCC	RCC	-DO-
11.	CW Pump House						RCC	RCC Pile foundation/RCC Spread	RCC	RCC	-DO-
12.	Chlorination Plant						RCC	Pile Foundation	RCC	RCC	-DO-
13.	ND Cooling Tower						RCC	Pile Foundation	RCC	RCC	
14.	B.A. Slurry Pit & Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
15.	Ash Compressor Building						RCC	Pile Foundation	RCC	RCC	-DO-
16.	Ash Handling Plant Control Building						RCC	Pile Foundation	RCC	RCC	-DO-
17.	Ash Water Pump House						RCC	Pile Foundation	RCC	RCC	-DO-
18.	Ash Pipe Rack						Structural Steel	Pile Foundation			
19.	Service & Technical Building						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01 .

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
20.	Clarified Water & Fire Water Reservoir						RCC	Pile Foundation	RCC	RCC	-DO-
21.	LFO/HFO Day Tank Foundation						RCC	RCC Ring Wall Foundation			
22.	FO Pressurizing Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
23.	Diesel Generator & Compressor Building						RCC	Pile Foundation	Colour coated galvanized sheeting	RCC	-DO-
24.	Side Stream Filter						RCC	RCC Raft on Pile			
25.	Store						RCC	RCC Spread	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
26.	Fly Ash Silo						RCC	Pile Foundation			
27.	HCSD Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
28.	LDO/HFO Pipe Corridor						RCC/ Structural Steel	Pile Foundation			
29.	Fire Water Tank						RCC	RCC Ring Wall Foundation			
30.	Fire Water/Clarified water Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-

Sl. No.	List of Structures/Buildings	Length (M)	Width (M)	Height (M)	No. Reqd.	No. of Storey	Remarks (Types of Building/Structure/Foundation)				
							Frame/ Structure	Foundation	Roof	Floors	Cladding
											SPC-001-IIG/2 section 3.03.01.
31.	Wagon Tippler						Structural Steel	RCC	Metal cladding		Metal cladding
32.	Transfer Point						Structural Steel	Pile Foundation	Metal cladding		Metal cladding
33.	Pent House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
34.	Crusher House						RCC	Pile Foundation	RCC	RCC	-DO-
35.	Stacker/Reclaimer						RCC	Pile Foundation/ Spread			
36.	Equipment Laydown Space						RCC	RCC Paving			
37.	RCC Retaining Wall						RCC	RCC Wall Foundation			
38.	FO Transfer Pump House						RCC	Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.
39.	Pipe Rack						Structural Steel	Pile Foundation			
40.	River Intake Pump house & Approach Bridge						Structural Steel	Well Foundation & Pile Foundation	RCC	RCC	For details refer K9213R-EPC-SPC-001-IIG/2 section 3.03.01.

13.00.00 **MISCELLANEOUS REQUIREMENTS**

Further to all requirements described in the preceding clauses, the following criteria shall be strictly complied with pertaining to analysis, design, layout & construction of aforesaid power plant.

13.01.00 Dense concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structure such as basement, pump houses, water-retaining structure, cable & pipe trenches etc., for achieving water tightness.

13.02.00 All joints, including construction and expansion joints for the water retaining structure shall be made watertight by using 230 mm (minimum) PVC ribbed water stops with central bulb. However, kicker type (Externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting.

13.03.00 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc., as per IS-6313 and other relevant standards.

13.04.00 Minimum 100 mm thick lean concrete 1 : 3 : 6 shall be provided below all underground structure, trenches etc., to provide a base for construction.

13.05.00 Not used.

13.06.00 Good quality fly ash bricks having compressive strength of minimum 50 kg/sqm shall be used. Ordinary clay burnt bricks of class designation 35 may be used for masonry work, if specified in Approved Architectural drawing. Bidder shall ascertain himself at site regarding the availability of clay bricks of minimum 35 kg/cm^2 compressive strength before submitting his offer.

13.07.00 All stairs shall have a maximum riser height of 175mm and a minimum tread width of 250mm. Minimum width of stairs in all buildings shall be 1200 mm.

13.08.00 All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab.

13.09.00 Each building shall be provided with minimum 1.0m wide reinforced concrete paving all round unless specified otherwise. Paving shall be sloped to provide a rapid run off of rainwater away from building.

13.10.00 The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

13.11.00 The steel columns below ground floors and upto minimum 100mm above finished floor level shall be encased in concrete.

13.12.00 Steel chequered plates and gratings shall be hot double dip galvanised. Thickness of coating will be 610gm/sq.m (minimum).

13.13.00 Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes

supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.

13.14.00 All drains inside the building shall have minimum 40 mm thick grating covers and in areas where heavy equipment loads would be coming, pre-cast RCC covers shall be used in place of steel grating.

13.15.00 All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off from platform.

13.16.00 For all buildings suitable arrangements for draining out of water collected from equipment blowdowns, leakage, floor washing, fire-fighting etc., shall be provided for each floor.

13.17.00 Finished ground floor level (plinth level) of all buildings shall be minimum 300mm above formation/grade level.

13.18.00 Duct banks consisting of PVC/GI conduits for cables shall be provided with concrete filling of M20 grade conforming to IS-456. The minimum depth of top of duct bank from grade level shall be 500mm.

13.19.00 All upstands and parapet walls on roof shall be of RCC construction for all buildings. Minimum height of parapet shall be 750 mm.

13.20.00 All architectural fins for the elevation of building shall be of RCC. Minimum thickness shall be 75mm.

13.21.00 All sand filling shall be compacted to minimum 95% of the relative density. For Tank foundation the compaction shall not be less than 85% relative density. Sand filling in Pit and trenches around structures refer Cl. No. 3.07.02,Volume IIG3, Section IV of tech. specification.

13.22.00 Back filled earth material shall be compacted as per design requirement subject to a minimum of 90% of the standard proctor's density at OMC.

13.23.00 All buildings shall have framed super structure. All walls shall be non-load bearing infilled panel walls.

13.24.00 50mm thick DPC shall be provided at plinth level before starting the masonry work.

13.25.00 Increased cover to reinforcement for all RCC structures as per IS-456 - 1978 shall be provided to withstand corrosive environment if there be any.

13.26.00 Not used.

13.27.00 All gates and stop-logs shall be of structural steel, which shall be hot double dip galvanised. Thickness of coating shall be 1000 gm/sq.m (minimum).

13.28.00 All mild steel parts used in the water retaining structures shall be hot double dip galvanised. Galvanising shall be checked and tested in accordance with IS-2629.

13.29.00 A screed of concrete layer not less than 100 mm thick and of grade not weaken than M10 conforming to IS-456 shall be provided below all water retaining

structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure.

13.30.00 Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 3.0 mm for a single flight.

13.31.00 Hand railing minimum 1000 mm high shall be provided around all floors/ roof openings, projections, balconies, walkways, platforms, steel stairs etc. All hand rails and ladder pipes shall be 40mm nominal bores MS pipe (medium class) and shall be galvanised (as per IS-277). All rungs for ladder shall also be galvanised as per IS-277 (medium class).

13.32.00 For RCC stairs, hand railing with 25mm square MS bar balustrades with suitable MS flats & aluminium hand rails (40mm) shall be provided.

13.33.00 All underground concrete structure like basements, pump house, water retaining structure etc., shall have plasticizer cum waterproofing cement additive conforming to IS-9103. In addition limit on permeability as given in IS-2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing. In case of water leakage in the above structures, injection method shall be applied for repairing the leakage.

13.34.00 The ground surface treatment in the switchyard area and in area around transformers shall be minimum 150 thick good quality pebbles / gravel with top layer of soil treated with antiweed chemical as per specification.

13.35.00 In the event the bidder encounter a difficult sub-soil condition which requires significant improvement incurring substantial expenditure, the bidder may adopt any patented method of soil improvement subject to Owner's approval. No extra cost shall be borne by the Owner in this respect.

13.36.00 For steel pipes encased in concrete, concrete encasement to steel pipe shall be with M20 grade of concrete and shall be of minimum 150 mm thickness all around pipe.

13.37.00 Ramps for building entrance shall be cast in situ RCC slab designed as a slab spanning over supports or rigid pavement resting on subgrade provided that the thickness of slab and the property of subgrade shall be such to ensure of its being treated as rigid pavement. The slope of ramps will not be more than 20°. Minimum thickness of slab shall be 150mm.

13.38.00 Only sewage and drainage pipe may run below road. Any other pipe like system water pipe may run beyond 1.0m from the edge of road along its longitudinal direction.

13.39.00 Provisions of safety, health & welfare according to factories Act shall be complied with. These shall include provision of continuous walkway of minimum 600mm wide along the crane girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

13.40.00 Minimum 2.4 M high fencing above toe wall shall be provided around switchyard, transformer yard, and other area, where fencing is necessary due to statutory requirements. Fencing shall comprise of 2.4m high PVC coated galvanised chain link fencing of minimum 8 gauge (including PVC coating) and minimum 11 gauge (without PVC coating) and of mesh size 75mm and galvanised barbed wire for switchyard and other areas upto a height of 0.6 m above chain link fencing excluding PVC coating shall not be less than 12 gauge. Steel entry gate shall be provided for all fenced areas. Top of toe wall shall be minimum 200 mm above the formation level.

For Unit #8 plant periphery fencing, above chain link fencing 750mm height concertina coil fencing shall be provided.

13.41.00 Trenches located outside building shall project at least 150mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of min. M-25 grade and shall not weigh more than 65 kg. Lifting hooks shall be provided in the pre-cast covers.

13.42.00 All cables & pipes in outlying area shall run above ground over steel trestle or other supporting structures for easy inspection and maintenance except in transformer yard area and some other local area where the same can run in RCC trenches. However laying of cables will be as per approved Electrical layout. In case of trestles with overhead racks and bridges minimum 7.0m head clearance shall be provided for road crossing.

13.43.00 For all trench structures, the bottom slope perpendicular to the run of the trench shall be minimum 1 in 200 and shall be minimum 1 in 500 for slope along the length of the trench.

13.44.00 Top of CW ducts shall be minimum 1.0 m below grade level.

13.45.00 For open horizontal drains, reservoirs concrete lining of minimum M15 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.

13.46.00 Provision for fire proof doors, nos. of staircases, fire separation walls etc., shall be made according to the recommendations of TAC.

13.47.00 Minimum size of structural elements shall be as follows:

13.47.01 **Concrete Slab & beam**

a)	Floor & roof slab	-	120mm
b)	Miscellaneous	-	50mm
c)	Ground floor slab	-	150mm
d)	Pre-cast cover	-	40mm
e)	Width of beam	-	150mm

13.47.02 **Structural steel**

For Joists	-	I - 150
For Channels	-	MC - 100
For Angles	-	L 50 x 50 x 6
Gusset plates	-	8mm thick

14.00.00 **STATUTORY REQUIREMENTS**

The Civil Engineering and building works shall comply with all appropriate statutory requirements including all current Building Control regulations, and with all planning or other conditions as required by the relevant local, state, and National authorities.

14.01.00 The contractor shall provide full general arrangement drawing (Civil, Structural & Architectural) of all buildings, structures and facilities to the Owner for comment. The Contractor shall not proceed with these drawings further without such comment. Any work carried out by the Contractor using drawings unacceptable by the Owner shall be at the Contractor risk.

14.02.00 The Contractor shall seek and obtain all necessary approvals and detailed planning consents outstanding at the time of placing the contract and shall be responsible for all necessary liaison with such authorities to obtain the same and for the payment of due fees for such approvals.

14.03.00 The Contractor shall obtain approval from the appropriate authority regarding the safe means of escape in the event of fire or other hazard before relevant construction work proceeds. As a minimum, the Contractor is required to ensure that the works shall comply with all statutory requirements including:

i) Central Government/State Government - for all building control regulation

ii) State factories act - For Safety, health & welfare, use of hazardous substance – including obtaining stability certificate and drawings to be approved by factory inspection.

iii) Central and State Pollution Board - For limits on pollution levels.

iv) Central Water Authority/State Irrigation Department - For Water obstruction/supply for withdrawal of water from local source, location of Intake pump house / Jack well.

v) State Water & Disposal Department - for waste & Foul Water disposal.

vi) Ministry of Environment - for all matters relating to environment.

vii) Ministry of Railway - for all matters for railway line construction.

viii) Traffic Advisory Committee - for regulation concerning fire safety/means of escape.

ix) Aviation Authorities - for clearance of tall structure like stack etc.

x) State Public Works Department - for regulations on Civil work/road works.

xi) Ministry of Forestry - for deforestation, if any, for site development.

14.04.00 The Contractor shall make due allowance for all necessary negotiation/ administration required and the time needed to obtain these permission and approvals in his programme. Failure to obtain such approvals in a timely manner shall not be a reason for extension of the programme.

15.00.00 **DOCUMENTS TO BE SUBMITTED**

The Contractor shall be required to prepare a `Basis of Design' for each Elements/Structures of Civil Works expanding on the information given in the specification. The `Basis of Design' shall include the following:

i) A concise description of the form of Structure considered.

ii) A statement of salient assumptions made.

iii) Codes of practice and references used

iv) A description of the design approach

v) Detail Calculations including Computer inputs & results with conclusion.

vi) Working drawings showing necessary details

These documents shall be submitted to Owner for review at least 12 weeks prior to the commencement of the relevant construction activity.

15.01.00 The submission shall be in accordance with dates set down in Contractors civil works design and construction programme.

15.02.00 The Contractor shall be required to carry out at his own cost, any rectification, alteration or replacement of works progressed within 12 weeks of submission of the design basis and drawings and resulting from engineers comments on the design submission.

15.03.00 Acceptance of the Contractor `Basis of Design' calculations or drawings by the Owner shall not relieve the Contractor of any of his obligations to meet all the requirements of the Contract or relieve the Contractor's responsibility for the correctness of design and safety of the structure for the design life of the plant. The Contractor shall make any changes in the design/drawing in the form of DCN without any financial implication, which are necessary to make the work comply with the contract.

15.04.00 **Calculations, Reports & Drawings**

The Contractor shall prepare detailed calculations for all structure / elements in accordance with cl. no. The Contractor shall also make available any additional calculations, other than routine structural calculation, as requested by the Owner during the period of Contract.

15.05.00 In addition to Geotechnical investigation report, the Contractor shall arrange and make available any other reports and investigations the Owner deems necessary for safety & stability of plant. The investigations shall be carried out in any standard laboratory of repute and as recommended by the Owner. All laboratory tests shall be carried out in the presence of Owner's engineer.

15.06.00 In the event, the Contractor adopts any patented method of design and Construction, not popular or practiced in this country; the Contractor shall sought prior approval of Owner in writing. The Contractor shall forward appropriate literatures, documents, certificates, case histories etc., to establish the viability of the method.

15.07.00 The bidder shall submit the tender with a schedule of proposed sub contractors for different construction packages (if necessary), structural consultants, (if any), any hired personnel for expertise, along with their name address, etc.

15.08.00 Each calculation document shall include the following

i) Contractor's name

ii) Package identification (if any)

iii) Designer's name/initials

iv) Checker's name/initials

v) Reference No.

vi) Index

vii) Date & Revision No.

viii) Revision identification mark

ix) Detail calculations including computer input data and output.

Calculation packages shall preferably be bound at A4 size sheets.

15.10.00 All working & construction drawings shall be drawn by CAD system, and shall be issued in A0/A1 size. The drawing shall include:

i) Name of Project, Owner, Consultant & Contractor.

ii) Title of the Drawing

iii) Drawing No. Issue Date, Revision No.

iv) Statement for Revision

v) Revision Identification Mark

vi) Release Status

vii) Designer/Checker’s/Draughtsman's name/initial

15.11.00 The Contractor, who shall maintain an upto date drawing & document register, shall monitor drawing & document issue. This register shall list all drawings & documents used in the design and construction for civil and structural works. The drawing register shall be a controlled document and shall be kept updated/revised and shall be issued on A4 size sheets.

15.12.00 All numerical analysis shall be done through computer. The bidder shall have either their own system or have access in other system outside their premises.

The Contractor shall be a bonafide license holder of any software package used in this project. Any in-house developed software may also be used subject to the approval of the Owner through validation with standard computer programme. Any pirated & unlawful use of software shall not be permitted. The Contractor shall furnish:

i) Name of Software

ii) Developing Agency

iii) A write-up/overview of the programme. As supplied by the copyrighter.

iv) Relevant documents verifying users right for using this software in this country.

15.13.00 All drawings, design documents, reports, correspondence pertaining to civil structural works shall be in `English Language'. Documents in any other language shall be translated in English before submitting to Owner.

All drawings, documents shall be forwarded in three (3) copies to Owner for approval/record.

16.00.00 **LAYOUT**

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall co-ordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy be found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderers shall take into account the cost of these in quoting their price.

17.00.00 **WORKMANSHIP**

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops

having proper equipment for accurate edge lanning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

18.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

19.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

20.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. Contractor shall furnish quality assurance and quality control plan. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing upto date progress on all important items of work.

21.00.00 ARCHITECTURAL WORK

For general specification and design criteria for Architectural work refer Volume IIG/2.

ANNEXURE-1

PRELIMINARY GEOTECHNICAL INVESTIGATION DATA

(Preliminary investigation work under progress. Investigation data will be made available by GSECL after completion of field investigation work)

VOLUME: IIG/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

CONTENTS

VOLUME: IIG/2 : GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

VOLUME: IIG/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORK

1.00.00 INTRODUCTION

This specification covers design, preparation of necessary drawings for approval and construction of all Architectural work associated with 1x800 MW Super Critical Thermal Power Plant to the satisfaction of the Owner. The scope of work covers complete Architectural Work including supply of all materials, labour, tools and plants as required for successful execution of the turnkey Contract.

The architectural work & services shall cover wall Cladding and finishing work of Plant buildings and non Plant buildings as listed in this documents but not limited to those buildings.

Architectural work are mainly Anti termite treatment work of the foundations, ground and other required surface areas, brick work for external walls and partition walls, Damp proof treatment course, pre coated metal cladding work and work for roof protection treatment, finishing of walls, painting, flooring & ceiling, false ceiling, false floor as required, doors, windows, ventilators and louvers, potable water supply system, sanitary, plumbing, landscaping and all other related work required for completion of the buildings & surrounding areas in all respect to render the premises acceptable to the satisfaction of the owner.

2.00.00 MAIN PLANT STRUCTURES/COMPONENTS

The general description of some of the major structures/components covered under this Contract have been given else where in this specification.

2.01.00 All buildings, structures shall be designed to meet its structural & functional requirements as stated in the relevant section of this document.

3.00.00 DESIGN REQUIREMENTS

3.01.00 The indicative location of various buildings have been shown in the plot plan drawing. Conceptual design for some of the important buildings have also been annexed with this document. The contractor shall develop the final architectural drawings of all plant buildings as per the final approved equipment layout and considering other related layout indicated elsewhere in this specification and the guide line drawings attached herewith. All non plant buildings shall be designed as per organizational chart of man power required for respective building and its functional requirements. All drawings shall need the approval of the owner before construction. The contractor shall also have to submit conceptual drawings of all important plant buildings prior to detailing work and coloured perspective view of the plant. Obtain approval from

statutory authorities, e.g., Factories Inspector, Explosives Inspector, Loss & Prevention association of India/Tariff Advisory Committee or any other statutory bodies as required shall be the responsibility of the contractor without any obligation to the owner.

All Architectural Work shall be done by a team of qualified Architects registered with the Council of Architecture.

3.02.00 The entire complex shall have an architectural character and style of its Own and shall also be visually and functionally integrated with the landscape Design.

The bidders must visit the site and study the environment prior to submission of the bid so that a harmonious as well as integrated architectural concept of the proposed phase of development is achieved. Special care must be given to enhance the visual and technological quality of the development by adopting latest state–of-the–art technology, materials and finishes.

Architectural concepts of the buildings shall offer its own identity and shall be aesthetically blended with the surroundings to give a pleasing appearance keeping an eye to the functional needs of the building.

Special attention shall be given in developing architectural design of the Power house, Technical and O&M building. Architectural design, selection of materials, its use and finishes shall take care of its visual quality as landmark, Aesthetic balance in its composition particularly in façade design with appropriate physical and functional integration.

Main Entrance of all buildings shall be inviting with projecting canopies and suitably and aesthetically designed lobby spaces.

Brief description of these buildings are given in this document.

3.03.00 Contractor shall comply with all applicable statutory rules for

a) Factories Act of the State.

b) Fire safety rules of TAC.

c) Act of the Pollution Control Board of the State.

d) All other statutory rules not mentioned but are to be observed for implementation of the project.

e) Laws/acts concerning control of Industrial effluents, Waste disposal and gaseous emissions.

3.03.01 Generally flat R.C.C. roof or RCC roof over metal deck in steel/RCC frame structure shall be provided for plant buildings. Cladding shall be either with brick work in cement, sand mortar or pre coated cladding over partly masonry wall up to a certain height as indicated below/or as approved during final detail engineering stage .

External Wall Cladding and roofing for the buildings shall be as follow:

Sl. No.	Name of the Building	External wall cladding	Roof
1.	Power house building	Brick wall up to 3.0 M from finish floor level above that pre colour coated galvalume (min. 0.6 mm total coated thickness) steel sheet with super polyester or Silicon polyester or Fluoro polymer (PVF2) coated insulated sandwitch sheet cladding of approved brand.	RCC roof over pre coated metal deck of total coated thickness 0,8mm with Roof water proofing treatment and necessary roof drainage slope.
2.	ESP Control Building	Brick Masonry Wall upto full height.	RCC roof with roof water proofing treatment & necessary roof drainage slope.
3.	Switchyard Control Room Building	- do -	- do -
4.	CW Pump House	Brick masonry wall up to full height	- do -
5.	Chlorination Plant Building	Brick masonry wall up to full height	- do -
6.	B.A. Slurry Pit and Pump House	Brick masonry wall up to full height.	- do -
7.	Ash Compressor Building	Brick Masonry Wall upto full height.	- do -
8.	Ash Handling Plant Control Building	- do -	- do -
9.	Ash Water Pump House	- do -	- do -
10.	Service and Technical Building	Brick wall up to full height of the building on all four sides.	- do -
11.	Clarified Water & Fire Water Pump House	Brick masonry wall up to full height.	- do -
12.	DM Plant & Chemical House	Brick masonry wall up to full height.	-do-
13.	FO Pressurizing Pump House	- do -	- do -
14.	Diesel Generator & Compressor House	Brick masonry wall up to full height.	RCC roof with roof water proofing treatment & necessary roof drainage slope.
15.	Store	- do -	- do -
16	Chemical House for pre treatment Plant	-do-	-do-
17.	Wagon Tippler	Shed type steel structure partly enclosed with cladding from top. Cladding shall be single sheet pre coated Galvalume profiled sheet	Slope roof with pre coated single Galvalume profiled sheet.

Sl. No.	Name of the Building	External wall cladding	Roof
18.	Transfer Point	Brick wall upto 3.0 M from finish floor level above that pre colour coated galvalume single sheet cladding similar to Power house cladding.	- do -
19.	Pent House	- do -	- do -
20.	Crusher House	Brick masonry wall upto full height.	- do -
21.	FO Transfer Pump House	Brick masonry wall upto full height.	- do -
22.	River Intake Pump House and approach bridge.	- do -	- do -
23.	Canteen Building	-do-	RCC slope roof finish with cement sand plaster in pattern of common clay tiles over Roof water proofing treatment. For RCC flat roof portion with water proofing treatment and necessary roof drainage slope.
24.	Yard Toilets	-Do-	RCC Roof with Roof water proofing treatment and necessary roof drainage slope.
25.	Watch Tower	Steel structure with Brick cladding for watch booth.	RCC roof for the watch booth
26.	HCSD Pump House	Brick wall upto 3.0 M from finish floor level above that pre colour coated galvalume single sheet cladding similar to Power House Cladding.	- do -
27.	CHP Control room	Brick masonry wall up to full height.	RCC Roof with Roof water proofing treatment and necessary roof drainage slope.
28	Fire Station Building	Brick Masonry wall up to full height.	RCC Roof with Roof water proofing treatment and necessary roof drainage slope

External brick wall for all buildings shall be one full brick thick wall except for fire wall. Fire wall shall be either one and half brick thick wall or RCC wall equivalent thickness of one and half brick wall or as approved by the owner and shall be provided where required to protect the building from fire hazards. Cladding shall be permanently pre coated metal cladding trough profile or as approved by the owner including its colours.

3.03.02 Brief Description of Service & Technical Building, Control Room and Canteen and Yard Toilets, Store Building.

a) **Service and Technical Building**

The Service and Technical building shall be of RCC frame structure building with RCC floor 4 storied building. Building shall be fully air conditioned Area of each Floor will be 400 Sq.M. It will have brick wall cladding on all four sides up to full height from finish ground level. Building is located adjacent to the Power House Building as shown in the Plot Plan. All weather access covered corridor shall be provided with powerhouse building at operating floor mezzanine and ground floor level or as required during final design stage. Ground floor shall house Maintenance shop, Tool store, Store for Mechanical and Electrical parts, Locker room with toilet facilities, Pantry, Supervisor, Maintenance In charge room, First Aid, PBX room, Spacious entrance lobby with one no Lifts for 8 passengers connecting all the four floors and at least two stair cases connecting all the floors and roof. Stair cases shall be so arranged that these are clearly connected with the fire escape/emergency escape route of each floor and satisfy the fire rule of the state and National Building Code. Fire rule of the state and National Building Code shall be guiding for designing the building. Fire doors as required as per Fire rule shall be provided.

Mezzanine floor shall accommodate Technical Staff office, Rooms for Maintenance in charge, Seminar room, Record room, Senior manager rooms, Room for Printer, Xerox and Fax M/C, Plotter M/C, Toilets for both Male and female and also for Physically impaired persons, Pantry, lift and stair lobbies.

First floor shall accommodate conference room, office for maintenance staff, Technical in charge rooms, Senior Mangers' room, Library, Document storage space, Service room, Ladies and gents toilet and also for Physically impaired persons, Pantry, lift and stair lobbies.

Floor at operating floor level/ Second floor shall accommodate Station in charge (O&M) chamber with attached toilet and P.A room, conference room, General office space, Accounts Department, small cash counter, Toilets for both ladies and gents and one toilet for physically impaired personnel, Pantry, lift and staircase lobbies.

Basic requirements floor wise are given above but not limited to the same. Changes of requirement as will be necessary during detail engineering stage shall have to be accommodated.

All the toilets and other Wet areas shall be connected with potable water connection.

Pantry of all floors shall have water cooler with RO system for drinking water facilities.

It is an important building for operation and maintenance of the plant as such shall have state of the art facilities and a highly sophisticated hi-tech expression and ambience with careful landscaped space around the building.

Building shall be provided with structural glazing for ample natural light penetration and other hard surfaces shall have finish with ACP veneering. Poly Carbonate canopy of Vault or Dome shape shall be provided at the main entrance. Main entrance shall be provided with large structural glazed panels with seam less double leaf door.

List of furniture to be provided in this building are given in Section No 12.000.

Floors plans are annexed for preliminary guide lines of the building.

b) **Control Room**

The Control Room of the Turbine Building is located at Operating Floor level. It is the Heart of the turbine building and shall be architecturally treated with state of the art facilities and technology.

The room will be fully air conditioned and have access from T.G hall Side. Access shall be provided through an airlock space with two glazed doors with an ante room in between. Glazed partitions shall be provided for clear visibility of the turbine hall as well as other ancillary rooms where visibility from control room are required. Type of glazed partitions single or double are as indicated in Cl. No. 7.07.01.

False ceiling of control room shall be as stated in Cl. No. 3.08.00.

Separate toilet in main control room shall be provided for Ladies & Gents and a exclusive pantry for control area. All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility.

c) **Canteen Building**.

Canteen building shall be provided for the staff with dining and Kitchen facilities. Area of Canteen building shall be approximately 220 Sq.M. The building will house a large dining hall for sitting of 60 persons at a time and shall be provided with an entrance lobby with 6mm thick clear float glass partition with glazed double leaf door in anodized aluminium frame. Large glazed windows in aluminium frame in all facade for Natural light shall be provided. Kitchen sufficiently large for cooking food with arrangement of Provision store, cold storage, Pot wash, Rest room for Cooking staff with locker and toilet facilities, Service entry for kitchen, Pantry for serving food from counter, hand wash room, Dish wash room.

Building shall be different from other buildings and shall be provided with RCC slope roof and finish with plaster in local clay tile pattern. Roof for Kitchen and other rooms may be flat RCC roof with Waterproof and roof water drainage system. Water proof treatment as per roof water proof treatment indicated in CL.No3.05.00 shall be provided in flat roof and slope roof. In slope roof treatment shall be provided below tile pattern finish and insulation shall not be provided. Under deck insulation shall be provided for slope roof portion. Kitchen shall be provided with smoke extractor chimney.

Entrance canopy with Poly carbonate vault shall be provided.

List of dining hall furniture to be provided in Canteen building are given in section 12.000.
All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility.

d) **Yard Toilets.**

Four (4) no of Yard toilets both for ladies and gents. shall be provided in the campus. Locations will be as decided by GSECL Each Yard toilet shall contain facilities for ladies and gents. In Gents toilet three no of WCs, two no baths with shower, three no Wash basins three no Urinals and a common space for drinking water facilities both for male and female shall be provided. In ladies toilet two no of WCs, two no wash basins shall be provided. One of the WC both in ladies and gents toilet shall be Western type WC.

e) **Store Building**

Store building shall be RCC framed structure building with RCC roof. Approximately total carpet area for store building shall be 1100 Sq.M. Store inside space shall be free from columns for free movement of the forck lift and bulk materials. In general 5 no storage space each approximately 200 Sq.M size shall be provided. In addition to the storage area approximately 100 Sq.m area shall be provided for Store office. Store office shall have accommodation for, store in charge, general office, Issue and delivery counter, Material receipt area, Toilet with 2 no WCs, 2 no wash basin, 2no urinals,1 no janitor room, and space for water cooler, Electrical service room etc. Storage area shall be provided for Heavy materials, Light materials and Costly materials. Storage spaces shall be designed in such a way that each storage area is internally connected with the store office area.

Open hard standing yard for Loading unloading bay, open stack yard and weigh bridge of 40 M.T capacity with a control booth shall also be provided. The entire store complex area shall be provided with 2.0M high brick masonry compound wall in RCC frame plastered and painted. M.S gates for vehicular entry and pedestrian entry shall also be provided.

All wet areas like pantry and toilet shall be connected with potable water. Water cooler with RO water plant of 50 L capacity shall be provided. Minimum two years free maintenance & guarantee are to be ensured for such RO facility

3.03.03 Windows, ventilators and louvers shall be in general as per the requirements of National Building code for natural light penetration and air flow. This may vary as per functional requirements. The sill height for low level windows shall be approximately 1000 mm above finish floor level.

3.03.04 Stairs & platforms shall be provided as required for maximum utility & safety and as per statutory requirements and relevant code of practice.

3.03.05 Damp proof course

50 thick DPC shall be provided at finish ground floor level.

3.03.06 Plinth protection

100 mm thick PCC 1:2:4 Plinth protection laid over compacted 75 mm brick balast with top smooth finish shall be provided all along the periphery of buildings with surface drain. Minimum 1000 mm wide plinth protection shall be provided for ancillary buildings. For power house building RCC Pavement of required width but not less than 2.0 M with surface drain shall be provided.

3.03.09 Miscellaneous Metal railing

Railing shall be provided as required from safety point of view and shall be as specified else where in the document.

3.03.10 All floors generally shall be of RCC with hatch-ways as required with 50 thick floor finish except for false floor.

3.03.11 Painting

Exterior masonry surfaces of all ancillary plant buildings excluding Power house building and Technical building shall be painted with exterior grade Acrylic emulsion paint of ICI/Dulux weather shield max/Asian apex Ultima over plaster. Exterior finish of power house and technical building shall be with structural glazing, ACP and sandwich cladding in general as shown in the drawing.

All structural steel work shall be painted with a Primer coat of epoxy resin based zinc phosphate with DFT 100 micron thickness.

Intermediate coat with epoxy resin based paint pigmented with titanium dioxide of DFT 100 micron thickness.

Top coat epoxy paint suitably pigmented of approved colour and shade with glossy finish of 75 micron thick with finishing coat of polyurethane of 25 micron thick.

All steel doors. Windows, ventilators, louvers etc and stair case MS railing and other railing shall be painted with epoxy paint 250 micron thick.

Wooden doors without lamination and wooden frame shall be painted with two coats of first grade synthetic enamel paint of Asian apcolite/ Neorolac/ Berger Luxol high gloss over a coat of primer.

Refer finish schedule Cl.No 3.18.00 for other painting details.

3.03.12 Miscellaneous Work

a) Counter tops in kitchen, washbasin ,pantry & similar areas shall be polished granite.

b) Pavement and walk ways unless otherwise specified else where in the document shall be with not less than 80 mm thick plastic molded interlocking concrete pavers suitable for heavy vehicle.

c) M.S grill in windows shall be provided as required from security point of view as per approved design.

d) Suitable arrangement of floor drains with trap shall be provided in floor where spillage of water may occur.

e) Covered car parking with RCC pavement for 10 no of cars and one shed for 20 no of two wheelers shall be provided. Structure shall be tubular vault structure with translucent PVC sheet similar to ONDEX bi-stretched PVC sheet.

f) All roofs shall be accessible from grade level by at least one staircase and for single storied buildings steel cage ladders shall be provided in case the roof is not earmarked for any equipment.

g) All external doors, windows, ventilators and rolling shutters shall be provided with sun and rain control device either by projecting RCC chajja or by recessing the windows, ventilators at least by 400 to 500 mm from external surface. Minimum 750 mm projection from external surface shall be provided for Doors and rolling shutters with vertical fins. For windows projection shall be minimum 500 mm from exterior surface and at least 150 extra projection from window jamb in each side shall be kept. Continuous chajja shall be provided where doors or rolling shutter and windows are provided side by side. RCC chajja over openings shall have Architectural feature to create a pleasing impact on the façade elevation.

h) Chain link fencing shall be provided as required from safety point of view.

Fencing shall be 3.0m high.

3.04.00 **Roof Insulation and Ventilation**

The RCC roof of all buildings shall be insulated with Expanded high density extruded polystyrene block. For roof ventilation relevant section of the specification shall be referred.

3.05.00 **Roof Waterproofing**

Generally all RCC roofs of all buildings other than power house and Service and Technical Building shall be provided with water proofing treatment comprising of concrete screed 1:2:4 in slope not less than 1:100. Top of Screed shall be provided with water proof treatment comprising of one coat of water proof chemicals of rubberized modified bituminous emulsion similar to EMUFAL TE of TEXSA or approved equivalent and 1.5 mm thick Self adhesive water proof membrane similar to Texself H.D of TEXSA or approved equivalent over chemical treatment. Top of water proof membrane shall be protected with 25 mm thick cement concrete 1:2:4 with 0.56 dia. chicken wire mesh. Top of protective layer shall be covered with extruded high density polystyrene insulation as per HVAC requirement but not less than 50mm thick. Top of insulation shall be protected with 25 mm thick cement concrete 1:2:4 with 0.56 dia. chicken wire mesh in panels of maximum size 1.2Mx1.2M. Joints shall be sealed with polysulphide sealant. Walk way where required shall be provided over roof surface for maintenance purpose and shall be with minimum 20 mm thick pressed pre cast concrete tiles on 15 mm thick Cement: Sand (1:4) mortar. Minimum 20% area of the roof shall be considered for walk way.

China mosaic finish flooring instead of Pressed precast concrete tiles shall be provided where cooling towers are located over terrace with proper drainage system.

3.06.00 **Partition Wall**

Generally full brick thick partition wall in 1:6 cement, sand mortar shall be provided except for toilet internal walls which shall be half brick thick in 1:4 cement sand mortar. 2 Nos. 6 mm dia. Rod shall be provided at every third layer. Full Glazed partition in anodized aluminium frame shall be provided for control room area so that clear view of the operating equipment and turbine hall is available from control room and various ancillary rooms in control room area.

3.07.00 **Plastering**

Exterior masonry wall, concrete surfaces and internal masonry and concrete surfaces shall be plastered with cement sand mortar.

3.08.00 **False Ceiling**

Control room in Power house and control room of other buildings including other air conditioning spaces shall have suspended ceiling with 84 x 12.5 deep x 0.5 mm thick inter-locking pre coated Aluminium alloy linear ceiling (LUXALON) on aluminium carrier.

Suspended ceiling shall take care of all illumination system, fire detection and fighting system, HVAC diffusers and other service system. Where required under deck insulation with fiber glass wool with aluminum foil backing shall be provided.

3.09.00 **Special Finish**

The main entrance of power house, control room and other important buildings like Technical & O&M building along with main stairs, lift lobby, entrance lobbies etc. shall be specially considered with interior design and finishes with special materials. Entrance to all buildings shall have special architectural features.

3.10.00 **Doors**

a) Generally hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas unless otherwise owner recommended for some other doors.

b) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required.

c) Special areas like control rooms shall be provided with aluminum glazed partitions and double doors with air lock i.e., two sets of doors with an air space. In between two doors an ante space shall be provided.

d) seamless double leaf fully glazed doors with 12 mm thick glass shall be provided in entrance door of Service and technical building.

e) Fire proof doors with panic bar devices shall be provided in cable spreader rooms and other areas having fire hazard and shall be provided as per LPA/ TAC requirements. Fire door shall be of approved manufacture and of minimum 2 hours fire ratings.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside. Weather strip shall be provided to all external doors as well as in all air conditioned area.

g) Panel doors in teak wood stiles and rails and panel with 12 mm thick marine ply wood shall be provided with both side laminations for toilets and other wet areas. Factory made flush door in BWR grade ply with both side laminated shall be provided in offices and other rooms of non plant building as per suitability and owners approval shall be provided all wooden doors shall be provided in Teak wood door frame. Aluminum frame glazed internal doors in some rooms of office as per owner's requirements shall be provided.

h) Specially fabricated sliding or double leaf side hung steel door shall be provided in mono rail location.

3.11.00 **Windows & Ventilators**

Generally for all plant buildings Aluminum casement windows and ventilators with 6mm thick clear float glass both for open able and fixed windows shall be provided. Aluminum casement windows shall be of approved Hindalco series and shall be minimum 15 micron thick anodized.

6mm thick clear wired glass shall be provided as required from safety point of view at higher elevation not less than 3.0M from finish floor level of the respective floor of the building.

Windows in Control room and air conditioned area shall be double glazed fixed windows hermetically sealed similar to glazed partition below. The exterior glass shall be bronze tinted heat reflecting glass as per approved sample.

3.12.00 **Glazing and Glazed Partition**

Glazing between A.C and non A.C areas shall be Insulating glass consisting of two 6mm thick clear float glass with a separating gap of 10 mm for thermal insulation. Both the glasses shall be hermetically sealed. Glazing between two A.C area shall be with 6mm thick clear float glass. All glazed partition shall be in aluminium 15 micron thick anodized frame.

3.13.00 **Sealant**

Silicon sealant shall be provided in all joints around exterior doors, windows, ventilators with masonry and concrete surfaces. Expansion joints shall be sealed with polysulphide sealant with back up rod and compressible filler.

3.14.00 **Landscaping**

Both soft and hard landscaping shall be developed for a pleasing environment.

Generally the natural contour shall be retained except where modifications needed for drainage or other technical reasons. Trees shrubs, hedges, earth mound, grass lawn shall be provided to suit the climate. Necessary irrigation system shall be provided for watering of the landscape area.

3.15.00 **Facilities in Buildings**

Facilities in each building shall be developed on the basis of requirements. Proper circulations and safety requirements shall be considered in each case. Plenty of natural light penetration through Windows, Structural glazing shall be one of the prime objective for each building. Architectural design shall ensure this aspect.

Adequate toilet and drinking water facilities with RO Plant system shall be provided for personnel working in each building. Each building and each manned floor shall have toilet facilities according to occupancy requirement as per NBC (National Building Code).

Ladies toilet shall be provided in each building as per requirements of the female occupancy in that building. Toilets for physically impaired personnel shall also be provided as per requirement of the owner.

3.16.00 **Potable Water System and Plumbing**

3.16.01 This system for various buildings shall be connected to the drinking water and service water system.

3.16.02 Water outlets shall be provided for an instantaneous flow rate of approximately 1.2 Cu.M/Hr. (5 GPM).

3.16.03 System will satisfy the state and local plumbing codes and regulations. In absence of the same NBC norms shall be followed.

3.16.04 Following I.S. Codes for the system shall be followed :

a) IS-2065 : Code of Practice for water supply in buildings.

b) IS-1172 : Code of basic requirements for water supply, drainage and sanitation.

c) IS-1200 : Laying of water and sewer lines (Pt.XVI) including appurtenant items.

d) IS-1239 : Specification for mild steel tubes and mild steel tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).

e) IS-3589 : Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

3.16.05 Potable water shall be supplied to basins, water closets, urinals, sinks, water coolers, showers and other plumbing fixtures as required. Soil and waste water piping shall drain through traps to the yard sanitary sewer system. All wash basins shall be connected to waste water disposal pipe through bottle trap.

3.17.00 **Roof Drainage Systems**

3.17.01 The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

a) Roof Drain Heads

b) Rain Water Down pipes

c) Fixtures

IS-1742: Code of practice for building drainage shall be followed for this purpose.

Multiple drains (min.2) shall be provided for all roof areas. System will be designed to handle rainfall at a rate of 90 mm per hour and in accordance with stipulations of IS-1742.

Roof drains will dispose rain water to storm water drain. Rain water pipes **shall run unexposed.**

All roofs shall be provided with access at least by one staircase. Cage ladder for single storied building may be provided where staircase is not provided in the building for maintenance of the roof drains and roof.

3.18.00 **Finish Schedule**

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
1.	All Turbine hall floors, (except operating floor of Power house building and floors of control building and any area requires special finish), AC plant, AHU room, Unloading bays, main-tenance & work-shop area, Fire tender area, Bulk Storage area of Store building. Loading un-loading area, ramp and loading dock and unless otherwise indicated ground floor of all plant buildings.	Heavy duty floor finish with non metallic hardener & suitable aluminium dividing strips.	Plastered & painted with acrylic washable distemper	RCC ceiling plastered & painted with min. two coats of acrylic washable distemper over coat of primer.
2.	Operating floor of Power house building. and Switchgear room and Following area of Store building: Store for costly, light & special materials, offices, entrance in front of office, locker room.	25 mm thick mirror polished Kota stone flooring over 1:4 mortar and required concrete under bed 1:2:4.	Plastered & painted with acrylic washable distemper	Metal deck ceiling / RCC ceiling Plastered & Painted with Acrylic Wash-able distemper.
3.	General circulation areas. Like passages, lobbies, corridors,Lift & stair entrance lobbies and corridors in all impor-tant areas like service & Technical building. Laboratories,	20 mm thick Mirror polished colour granite in large slab as per Owner's choice in 1:3 cement sand mortar & required concrete under bed 1:2:4.	Plastered & painted with acrylic emulsion paint Over wall putty. Lift front shall be finished with 20mm thick mirror polished pink or any approved coloured granite slab of approved texture.	RCC ceiling plastered & painted with acrylic emulsion over wall putty. False ceiling if required shall be provided with Luxalon.

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
	Passage, lobbies and other areas of all non plant buildings.	Skirting on stair treads shall be with coloured granite as per Owner's choice.	.	.
4.	Cable vault, cable spreader,, all Pump houses, DG room & similar other areas.	Heavy duty floor finish with metallic hardener & dividing strips	Plastered & painted with acrylic washable distemper.	RCC ceiling plastered & painted with acrylic wash-able distemper.
5.	RCC stair case in all buildings except Service and Technical building.	20 mm thick mirror polished coloured granite slabs in treads and risers in 1:3 mortar and cement slurry & required concrete under bed. Granite slab shall be in one single slab for stair width up to 1500 both for treads & risers. Three no grooves 6 x 5 mm along the length of the tread shall be provided for grip. Granite shall be as per owner's choice.	Plastered and painted with acrylic emulsion paint Over wall putty.	RCC slab/ceiling plastered & painted with acrylic emulsion over wall putty.
	For Service Building	20 mm thick mirror polished granite in cement sand mortar 1:3 with cement slurry and required under bed. Granite slab shall be in one single slab for stair width both for tread and riser. Three no grooves 6 x 5 mm along the length of the tread shall be provided for grip Skirting shall be as stated in Sl no 3		
6.	Control room and other areas where false floors are required.	False floor min. 600 high from base slab removable type with steel hollow panels coated with	Plastered & painted with acrylic emulsion paint Over wall putty.	False ceiling with aluminum linear false ceiling of Luxalon..

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
		epoxy paint on exposed surface and factory laminated antistatic HPL/PVC at top with 6mm beading on all sides for edge protection..Panels shall be mounted on detachable steel pedestal and grid system as per specification.		
7.	All air conditioned areas in control room where false floors are not required, MCC room, office areas, conference room, shift in charge room, Engineers' room.	10mm thick 600 x 600 vitrified tiles over 1:3 mortar including cement slurry and concrete under bed 1:2:4 as required.	Plastered & painted with acrylic emulsion paint Over wall putty.	False ceiling with Aluminum. linear ceiling of Luxalon as per approved lay out.
8.	Battery & battery Charger room and Acid prone similar areas.	Min. 20mm thick acid alkali resistant tiles set in & jointed in Silica based epoxy mortar. 2100 high Dado of similar tiles.	Acid resistant resin based epoxy coating over two coat of Deckurds-s manu-factured by fosrocks or equivalent paint over remaining wall surfaces.	.Acid resistant resin based epoxy coating over two coat of Deckurds-s manufactured by fosrocks or equivalent paint
9.	Toilet, pantry, Yard toilets, Kitchen, Pot wash of Kitchen, hand wash and dish wash area & other similar wet areas of all buildings (plant and non plant)	Mat finish coloured designed ceramic tiles in 1: 3 cement sand mortar/title size 300 x 300 x 7.2 mm. Glazed coloured designed ceramic wall tiles dado 300x 450 x 8mm thick up to full height	Plastered & painted with acrylic emulsion paint over wall putty.	Plastered & painted with acrylic emul-sion paint over wall putty. False ceiling shall be provided with Luxalon to reduce the ceiling height of Toilet where required as per requirement of owner. Height of toilet shall be 3000 mm from finish floor level.
10.	Sunken floor in toilets	Sub floor painted with EMUFAL T.E of TEXSA or eqv. and one layer of Water proof 1.5 mm thick self adhesive water proof	Side walls of sunken floor similar to floor treatment.	-

Sl. No.	Building/Area	Floor/Skirting/ Dado	Wall	Ceiling
		membrane of TEXSA or Eqv. Including 50 mm thick PCC 1:2:4 protection layer (Treatment similar to roof water proofing) Hydro test shall be carried out after completion of water proofing by filling water for 48 hours.		
11.	Floors and RCC stair in areas prone to slippage	Antiskid finish with neat cement with chequered tile pattern.	-	-

Skirting in all floors shall be 150 mm high and shall be of similar material of floor

1.5 mm thick wall putty finish shall be provided where Acrylic Emulsion paint is indicated.

All internal M.S components, doors both wooden and steel shall be painted with two coats of paint over a coat of primer/wood primer for wood surface.

Fire door shall be painted with Post office red shade.

All aluminum Doors and windows sills, jambs and heads shall be provided with Minimum 12 mm thick large granite slab in 1:3 mortar. Such finishes shall be provided in all important buildings as per owner's choice

False flooring area and toilet area shall be provided with Sunken slab to get false floor finish at same level as adjacent floor. Sunken floor below false floor shall be given two coats of synthetic enamel paint over one coat of primer.

3.18.01 During execution of the contract, the contractor shall take approval from the owner of all building materials and finishing items (e.g. various tiles, doors, and windows, paints etc.) to be used for the contract by submitting samples and/or product literature as appropriate.

4.00.00 **WORKMANSHIP**

Workmanship for architectural work shall be of the best possible quality and all work shall be carried out by skilled workmen except for those work which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. In addition to the requirement specified above, if the by laws of the local Govt., Municipal or other authorities require the employment of licensed or

registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the representative of the manufacturers to ensure that the work is being done according to the manufacturer's specifications and details.

5.00.00 DOCUMENT SUBMISSION

Design and Construction documents including architectural drawings & finish schedule pertaining to all Architectural work shall be required to be submitted to Owner/Owner's Consultant for their approval. Approval of these documents by the Owner/Consultant shall not relieve the Contractor of his responsibility for any errors and fulfillment of Contract requirements. No of documents to be submitted shall be as mentioned elsewhere in the tender document

5.01.00 As Built Drawings

"As-built" drawings shall be prepared by the Contractor after completion of construction/erection incorporating all the changes, if any, done on Engineer's instruction/approval. The number of prints and film based reproducible transparency and CD to be submitted for Design, Construction documents and As- Built drawings mentioned elsewhere in the specification, stipulations made in Section G-0 shall prevail. No of documents to be submitted shall be as mentioned elsewhere in the tender document.

6.00.00 CODES AND STANDARDS

Following is a general list of Codes and Standards to be used in the design of the Plant. Specifically applicable codes and standards shall be identified in System Design Descriptions/Technical Specifications as appropriate. The latest editions/revision of following codes and standards along with addendums/ amendments, if any, shall be followed.

6.01.00 General

a) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards.

b) National Building Codes of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Work.

e) IS-1256 : Code of Practice for Building Bylaws.

6.01.01 Masonry

a)	IS-712	:	Building limes.
b)	IS-1077	:	Common Burnt Clay Building Bricks.
c)	IS-1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
d)	IS-1528	:	Methods of sampling and physical tests for refractory materials.
e)	IS-1597	:	Code of practice for construction of stone masonry (all parts).
f)	IS-2212	:	Code of practice for brickwork.
g)	IS-2116	:	Sand for masonry mortars.
h)	IS-2185	:	Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i)	IS-2250	:	Code of practice for preparation and use of masonry mortars.
j)	IS-2572	:	Code of practice for construction of hollow concrete block masonry.
k)	IS-2691	:	Burnt clay facing bricks.
l)	IS-3414	:	Code of practice for design and installation of joints in buildings.
m)	IS-3495	:	Methods of tests of burnt clay building bricks.
n)	IS-4441	:	Code of practice for use of Silicate type chemical resistant mortars.
o)	IS-4860	:	Acid Resistant Bricks.

6.01.02 **Doors, Windows and Ventilators**

a)	IS-399	:	Classification of commercial timbers and their zonal distribution.
b)	IS-883	:	Code of practice for design of structural timber in building.
c)	IS-1003	:	Timber panelled and glazed shutters (all parts).
d)	IS-1038	:	Steel doors, windows and ventilators.
e)	IS-1081	:	Code of practice for fixing and glazing of metal

				(steel and aluminium) doors, windows and ventilators.
	f)	IS-1361	:	Steel windows for industrial buildings.
	g)	IS-2835	:	Transparent sheet glass for glazing and framing purposes.
	h)	IS-1948	:	Aluminium doors windows and ventilators.
	i)	IS-1949	:	Aluminium windows for industrial building.
	j)	IS-2191	:	Wooden flush door shutters (Cellular and hollow core type).
	k)	IS-2202	:	Wooden flush door shutters solid core type).
	l)	IS-3103	:	Code of practice for Industrial ventilation.
	m)	IS-3548	:	Code of practice for glazing in buildings.
	n)	IS-3614	:	Fire check doors.
	o)	IS-4021	:	Timber door, windows and ventilator frames.
	p)	IS-4351	:	Steel door frames.
	q)	IS-6248	:	Metal rolling shutters and rolling grills.

6.01.03 **Roof and Flooring**

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof.
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses.
c)	IS-2210	:	Criteria for Design of R.C. shell structures and folded plates.
d)	IS-809	:	Rubber flooring materials for general purposes.
e)	IS-1195	:	Bitumen mastic for flooring.
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring.
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors.
h)	IS-1237	:	Cement concrete flooring tiles.
i)	IS-1443	:	Code of practice for laying and finishing of

cement concrete flooring tiles.

j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish.
k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring.
l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping.
m)	IS-5766	:	Code of practice for laying burnt clay brick flooring.
n)	IS-1197	:	Code of practice for laying of rubber floors.
o)	IS-2441	:	Code of practice for fixing ceiling coverings.

6.01.04 **Waterproofing**

a)	IS-1322	:	Bitumen felts for waterproofing and damp proofing.
b)	IS-1346	:	Code of practice for waterproofing of roofs with bitumen felts.
c)	IS-1609	:	Code of practice for laying damp proof treatment using bituminous felts.
d)	IS-3036	:	Code of practice for laying lime concrete for a waterproofed roof finish.
e)	IS-3037	:	Bitumen mastic for use in waterproofing of roofs.
f)	IS-3067	:	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
g)	IS-3384	:	Bitumen primer for use in water proofing and damp proofing.
h)	IS-4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.

6.01.05 **Water Supply, Drainage and Sewerage**

a)	IS-404	:	Lead pipes.
b)	IS-458	:	Concrete pipes.
c)	IS-651	:	Salt glazed stoneware pipes and fittings.
d)	IS-771	:	Glazed fire-clay sanitary appliances (all parts).

e)	IS-774	:	Flushing cisterns for water closets and urinals other than plastic cisterns.
f)	IS-783	:	Code of practice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200	:	Method of measurement : Laying of [Part XVI] water and sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
s)	IS-3486	:	Cast iron spigot and socket drain pipes.
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
v)	IS-1230	:	Cast iron fittings for pressure pipes for water, gas and sewage.

w)	IS-1230	:	Cast iron rainwater pipes and fittings.
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y)	IS-784	:	Prestressed concrete pipes.
z)	IS-1726	:	Cast iron manhole covers and frames.
aa)	IS-5961	:	Cast iron grating for drainage purposes.
bb)	IS-5219 [Part-I]	:	"P" and "S" traps.
cc)	IS-772	:	General requirements for enamelled cast iron sanitary appliances.
dd)	IS-775	:	Cast iron brackets and supports for wash basins and sinks.
ee)	IS-777	:	Glazed earthenware wall tiles.
ff)	IS-2548	:	Plastic water closet seats and covers (all parts).
gg)	IS-2527	:	Code of practice for fixing rainwater gutters and downpipes for roof drainage.

6.01.06 **Painting**

a)	IS-348	:	Specification for French Polish.
b)	IS-427	:	Specification for Distemper, dry colour as required.
c)	IS-428	:	Specification for Distemper, oil emulsion, colour as required.
d)	IS-1477	:	Code of practice for painting of ferrous metal in buildings.
e)	IS-2328	:	Code of practice for finishing of [I & II]wood and wood based materials.
f)	IS-2339	:	Specification for Aluminium Paints for general purposes in dual containers.
g)	IS-2395	:	Code of practice for painting concrete, masonry and plaster surface.
h)	IS-2932	:	Specification for enamel, synthetic, exterior: i) Undercoating ii) Finishing

i) IS-2933 : Specification for enamel, exterior:

i) Undercoating

ii) Finishing

j) IS-5410 : Specification for cement paint.

Any other code which is not indicated above but may be required in course of design, construction, and review shall also be referred.

7.00.00 BRIEF SPECIFICATION OF ARCHITECTURAL WORK

7.01.00	Anti termite Treatment	: Anti termite treatment as per IS 6313 Part (ii) with chlorepyriphos emulsifiable concentrate conforming to IS:8944 with 1% concentration or approved equal as per manufacturer specification.
7.02.00	Brick work	: 230 mm thick fly ash brick wall with 1:6 Cement : Sand mortar. Compressive strength shall not be less than 100 Kg/ Sq. Cm.
7.02.01	Half brick thick walls for toilets' internal walls and other small partition wall.	: 1:4 Cement & Sand Mortar with 2 Nos. 6 mm M.S. bars at every 3rd course.
7.03.00	Damp proof course	: 50 mm thick 1:1.5:3 concrete with a minimum of 2% admixture of water proofing compound and shall be provided at plinth level. Plinth level of all buildings shall be minimum 300 mm above finished grade level or as approved at the final stage of design work.
7.04.00	Plaster :	
7.04.01	Internal	: 12 mm thick 1:6 Cement Sand plaster for even side of the wall and 15 mm at the rough side of the wall.
7.04.02	External	: 20 mm thick cement sand plaster to be laid in two layers. Bottom layer 12 mm thick with 1:3 cement sand mortar and top layer 8 mm thick with 1:1 cement sand mortar with fine sand. 20 mm thick external plaster with similar mix cement sand plaster shall be provided where specially required or as per manufacturer's specification for any special decorative finish.
7.04.03	Ceiling	: 10 mm thick 1:4 Ceiling plaster over concrete surfaces except in cable vault area.
7.04.04	Punning over plaster	: 1.5 mm thick wall putty punning over plaster. In general wall putty shall be provided over plaster

for all air conditioned rooms, entrances and lobbies, offices, conference room and all special areas which are to be painted with acrylic emulsion paint and as indicated in finish schedule.

7.05.00 Cladding for Power house, and other buildings where cladding shall be provided. : a) Exterior walls shall be of 230mm thick brick wall up to 3000 mm height in general from finish ground floor level. Fire wall where required shall be provided for 2 to 3 hours fire resistance and of required height as per statutory code or TAC/LPA rule for particular equipment and particularly in transformer yard portion. Other sides unless required by any specific rule or codes height of Brick wall shall be up to 3000 height from finished floor level. In case of Power house Wall in boiler side ie along C row shall be brick wall up to full height. Wall in service and technical building will be brick wall up to full height. Power house wall at that gable end above the height of service building shall be sandwich metal cladding.

The upper part of the external wall above brick wall single sheet/insulated sandwich metal cladding (profiled) shall be provided. Metal cladding shall be permanently pre coated with Fluro polymer (PVF-2) over zinc aluminium high tensile (550MPA) steel profiled sheet of minimum 0.6mm TCT thick (total coated thickness) and shall be of approved manufacturer. For uniformity metal cladding wall along 'A' row in power house and gable end not adjacent to service building shall be from 3000 height. Metal cladding over parapet and brick wall shall be single sheet cladding.

7.06.00 Filler Wall : a) 150 high curb of half brick thick shall be provided between edge of floor slab and cladding. curb wall where required shall be provided up to window sill.

b) control equipment room and other Air conditioned rooms in the operating floor shall be provided with half brick thick curb wall up to window sill and Remaining surfaces up to false ceiling/structural slab shall be provided with Double layer 12.5 mm thick Gypsum board over Gyp steel channel, all steel columns shall be covered with Double layer Gypsum board over Gyp channel.50 mm rock wool insulation shall be

provided at back in air conditioned area. Other control rooms with cladding shall have similar treatment.

For special interior finish in control room for Power house Aluminium Composite panel (ACP) 4mm thick Fixed in aluminium frame shall be provided. ACP shall be with 0.5mm toping of pre-coated aluminium foil on both side with 3mm core and of approved manufacturer & approved shade. Steel column encasement shall also be with similar materials and details with necessary backing as required.
In toilet block brick walls shall be provided up to false ceiling height. Battery room, battery charger room shall have brick wall up to dado height ie 2250 high.

c) The upper floor slabs shall be extended up to cladding with a gap of 25 mm. The gap between RCC floor slab and Cladding in air conditioned area shall be sealed with Extruded Polystyrene block. In other areas shall be provided only if required by HVAC.

7.07.00 **Doors & Windows**

7.07.01 Doors : a) Doors shall be steel doors consisting of double plated hollow flush door shutters with pressed steel door frame and shall be provided for plant and utility areas. Doors shall be minimum.1000 wide and 2100mm height. For single leaf door. For double leaf door width shall be 1500 mm minimum. Equipment entry door shall be as per the requirement of Equipment movement through door.

b) Door shutter shall be 45 mm thick with two outer sheets of 1.25 mm thick steel sheet rigidly connected with continuous vertical & horizontal stiffeners 1 mm thick @ 150C/C top and edges of shutter shall also be reinforced by continuous stiffener channel.

c) Doors shall be sound deadened by filling the inside with Mineral wool insulation.

d) Door frame shall be pressed steel frame from 1.6 mm thick sheet and shall be filled with concrete/cement sand mortar 1:6

e) Large door in monorail location shall be specially fabricated and provided where required.

f) Fire proof doors shall be provided on division walls of cable spreader rooms and at all fire exit points as per recommendation of Tariff Advisory Committee/LPA. These shall be as per IS:3614. Fire resistance grade of the doors shall be as per LPA/TAC requirements. However, minimum fire resistance grade shall be for 2 (two) hours.

g) Doors of control room, control equipment room, computer room, and other important rooms and entrance doors of all important buildings shall be aluminium glazed doors. Doors shall be of double swing type with floor spring. For control room, control equipment room, etc. glazed wall panels with aluminium frame shall be provided between air-conditioned and non-air-conditioned areas and on the side of control room facing the operating floor to have a clear view.

Glazed door as required shall be provided in glazed partition.

Single Glazed panel with aluminium frame work shall be provided as partition between two air-conditioned areas where clear view is necessary. All aluminium frame shall be 15 micron thick anodizing coating. Main entrance door to control room and control equipment room shall be with air locked lobby by providing two Aluminium Glazed doors with a ante room/space in between.

All aluminium section shall be of approved HINDALCO sections.

h) Internal Doors of W.C and bathrooms shall be wooden panel door with teak wood frame. Refer Cl. 3.10.00 frame shall be 100x60 mm size.

i) Vision panel in door with 6 mm thick clear glass of size 250 x 400 shall be provided where required.

j) All doors shall be provided with necessary approved quality hardware. Hardware schedule for both door and windows shall be furnished for approval.

7.07.02 Windows

a) All windows and ventilators shall be aluminium casement glazed windows and ventilators. Aluminium sections shall be of

HINDALCO approved series of minimum 15 micron thick. anodize coating.

b) Hardware of approved quality shall be provided as required.

c) Fixed M.S. grill shall be provided in all windows in MCC room in ground floor and other rooms where required from security point of view.

d) P.S. louvre shall be provided as per requirement of HVAC.

7.07.03 Rolling shutters : Rolling shutters with suitable operating arrangement (mechanical and/or electrical) according to size shall be provided in buildings to facilitate handling & transportation of equipment. All rolling shutter shall be of approved manufacturer. All Rolling shutter shall be Electrically & Mechanically operated.

7.07.04 Glazing and glazed partition & Structural glazing, polycarbonate vault canopy : a) Thickness of glazing shall be 6 mm thick clear float glass according to panel sizes and shall be provided in all windows which are within 3000 height from finish floor level. All other fixed windows at upper level shall be provided with 6 mm thick clear wired glass or as approved during final design stage.

b) All external windows in control room at operating floor shall be double glazed hermetically sealed with 10mm gap. Both the glasses shall be 6mm thick toughened float glass. Inner glass shall be 6 mm thick clear glass and outer glass shall be 6 mm thick tinted heat reflecting glass.

c) FIXED glazed window between A/C and non A/C area shall be double glazed aluminium casement windows. With 6 mm thick clear float toughened glass.

d) Glazing in control room between two AC areas shall be with single glazed wall panels with 6 mm thick toughened clear glass with aluminium frame. Glazing between A.C and non A.C area shall be double glazed with two clear toughened glass similar to window above and shall be hermetically sealed.

e) 4 mm thick ground glass shall be provided for toilets.

f) 6.0 mm thick float glass shall be provided for doors. For control room door clear float

toughened glass 6.0 mm thick shall be provided.

g) Structural glazing in facade treatment of Power house/Technical and Service building shall be provided for special Architectural treatment of the façade. Structural glazing shall be 6 mm thick tinted heat reflecting toughened glass fixed over aluminium frame backing using structural silicon 995 grade or as approved of DOWCORNING or equivalent and ensuring weather sealing using 789 DOW CORNING OR AS APPROVED. The system shall be capable to withstand the most aggressive climate of the area. All brackets and supports shall be of stainless steel and shall be fixed by HILTI fastener system. Shadow box as required shall be provided to hide the beams from vision. Stainless steel capping shall be provided at top to prevent ingress of water. The work shall be carried out through approved vendor expertise in this type of work.

h) Clear translucent vault cover with lexan thermo clear multi wall polycarbonate sheet of G.E. plastic with both sides UV protection and thermal insulation properties and 6 mm thick with all necessary structure, EPDM gasket with aluminium flats etc. shall be provided for entrance canopy/porch for Power house/Technical and O&M Building.

7.07.05 False Ceiling for air-conditioned areas : a) Control room in power house, Conference room and special rooms in Technical building shall) suspended from steel members or RCC slab/beam with anchor fastener by concealed suspending system as per manufacturer's detail. Filler vertical panel shall be provided to hide the metal cladding member of control room and its allied areas. Lighting shall be indirect lighting. AC diffusers shall be continuous type.

False ceiling for other area shall be as per Cl. No. 3.08.00

c) Resin Bonded glass wool insulation minimum 25/50 mm thick as per HVAC requirement in aluminium foil backing shall be provided over false ceiling for thermal and acoustical insulation. The density of

glass wool shall be 32 kg/cu.m (minimum) and shall conform to IS 8183. Maximum value shall be 1.0 W/sq.m/deg.C.

d) Underdeck insulation as per HVAC requirement minimum 50 mm thick High density polystyrene blocks 30kg/CuM density shall be provided.

7.07.06 Floor finish : Floor finish shall be in general 50mm thick shall be as per floor finish details. Refer finish schedule Cl. 3.18.00.

7.07.07 Roof : a) All roofs shall be provided with water proofing treatment as indicated in Cl. 3.05.00.

b) The slope shall be 1:100 for quick disposal of rainwater. Grading under bed 1:2:4 & 1:4 cement sand plaster shall be provided where structural slopes are not provided. 1:4 plaster at end slope shall only be provided if required at end to maintain the slope.

c) The contractor shall give guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for ten (10) years. The mode of execution of the guarantee shall have to be acceptable to the owner.

d) In general Heavy duty 110/150 dia. as required PVC rain water down comers with water tight as per manufacturer specification and medium class galvanized mild steel pipes conforming to IS:1239/ IS:3589 shall be provided particularly to drain off rain water from the roof. The numbers and size of down comers shall be governed by IS:1742 & IS:2527. Galvanized rain water down comer shall only be provided in Power house shall have threaded joint.

7.07.08 Painting : a) External masonry surfaces of all buildings shall have two coats of exterior grade acrylic emulsion paint of Asian Paint/ICI/Berger over a primer except service & technical building External masonry surfaces of these buildings shall be finished with minimum 2 coats of exterior grade acrylic emulsion paint over coat of primer. External surface of

service building shall be finished mainly with ACP (Aluminium Composite panel) veneering and structural glazing

b) Internal surfaces shall be finished as per finish schedule Cl. 3.18.00.

c) Oil resistant paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

d) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

7.07.09 Stairs : a) All RCC stairs shall have not more than fourteen (14) risers in one flight. Height of risers and width of treads shall be 150 mm to 167 (max) and 300 mm respectively. Min. width of stairs shall be 1500 mm for RCC Main stair-case. For other emergency/fire escape staircase maximum steps in each flight shall be 13 nos. Tread 250mm and riser 180 max width of staircase 1200 clear.

b) Hand railing min. 1.0 meter high shall be provided around all floor/roof openings, projections/balconies, walkways platforms & steel stairs. All hand rail shall be min. 40mm nominal bore MS pipe (medium class) and shall be galvanized as per relevant IS code and shall not be less than 450g/m^2. All rungs for ladder shall be min. 16 dia. and galvanized with 650gm/ zinc/sq.m.

c) For all RCC stairs 25 mm square MS bar balustrades with 30x6 mm thick MS flats and aluminium handrail of INDAL SECTION NO. 5116 shall be provided and fixed to MS flat brass shoe for each balustrade shall be provided.
Stainless steel railing as per approved design shall be provided in Service & Technical building.

7.07.10 Draining out water from floors : For all buildings, suitable arrangement for draining out water collected from equipment, blow down, leakages, floor washings, fire fighting etc. shall be provided for each floor, complete up to station sewers. All drain out pipe shall be provided with Floor traps at the end.

List of Products which are to be used in the buildings are given in

Cl.11.00.00 and List of furniture which are to be provided in Service and

Technical Building and Canteen building are given in Cl.no 12.00.00

8.00.00 **WORK**

8.01.00 **Fencing**

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, transformer yard, building transformer area, and other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high PVC quoted galvanized chain link fencing of minimum 12 gauge (including PVC coating) of mesh size 75 mm and galvanized barbed wire for switchyard/transformer yard.

Galvanized barbed wires of a height of 0.6 metre shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauge. Steel entry gate shall be provided for all fenced areas. Top of toe wall shall be minimum 200 mm above the formation level.

Periphery fencing of unit # 8 shall be provided with GI concertina of 750 dia in Y shape angle MS post.

The fence around switchyard area shall comprise of 12 gauge G.I. PVC coated chain link fencing of mesh size 75 mm to a height of 2.4 m above the toe wall with a 600 mm high galvanized barbed wire at the top such that total fence height of 3.0 m above toe wall level is achieved. Toe wall shall be minimum 200 mm above the formation level.

The chain link will be stretched and attached by `C' clips at 0.5 m intervals to 3 strands of high tensile spring steel wire (HTSSW) of 12 gauge interwoven in chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link fence 600 mm high Barbed wire fencing shall be provided. Three prong standard barbed wire in four lines at equal division shall be fixed with M.S angle post bent to 45 degree angle towards inside.

All fence posts shall be 75 x 75 x 6 MS angles spaced at 2.5 m C/C distance. All straining posts i.e., end posts shall be 75 x 75 x 6 MS angles. All corner posts will have two stay posts of size 65 x 65 x 6 MS angles and every tenth post will have a transverse stay post. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions. Toe walls either of brick masonry with bricks of minimum 50 kg/cm^2 compressive strength shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the switchyard grade formation level with PCC coping (1:2:4). All gates shall be of hot dipped galvanized structural steel as per specification.

Chain link gate with M.S. angle frame, MS flats, `T' metal track, roller, gun metal shoe etc. shall be provided as required in the fence for vehicular and man access gate.

All structural steel work for the fencing shall be painted with synthetic enamel paint over a suitable primer.

9.00.00 WATER SUPPLY AND SANITARY WORK

9.01.00 Water Supply and Sanitary Work :

a) PVC roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building. Tank shall be Sintax tank or approved equal.

b) Galvanised MS pipe of heavy duty class shall be provided for internal concealed piping. Piping work for potable water supply. Exposed GI pipe may be medium class. All water supply line in internal wall shall be concealed pipe work.

c) Heavy duty PVC pipe conforming to IS 15328 with joints as per manufacturer specification shall be used for sanitary work below ground.

d) Heavy duty PVC pipe conforming to IS 15328 with joints as per manufacturer specification shall be provided for sanitary work above ground.

e) 100 mm thick 1000 mm wide plinth protection with plain cement concrete 1:2:4 with top smooth finish over an under bed of 75 mm thick (nominal) over 40 mm (nominal) dry brick ballast well compacted & grouted with sand.

f) Brick/RCC surface drain shall be provided all around the building with slope 1:250 to 300 & connected to area drain. 40 thick. M.S. gratings/RCC slab shall be provided over surface drain at the location of entry, vehicular crossing etc. Size of drain shall be as per quantity of rain water to be disposed off and shall not be less than 300 wide x 300 depth.

g) All underground pipeline should be provided with bituminous paint & wrapping coating prior to Hydro test

9.02.00 Toilets

Minimum one toilet shall be provided in each building. The no. of WC, wash hand basin, urinals etc. shall be as per the no. of users. Toilet blocks in control room building shall have arrangement for both Gents & Ladies toilet.

For toilet block with two or more W.C.S at least one toilet shall be of Indian type.

For multilevel toilet block & toilet in upper floor ventilation shaft/pipe duct shall be provided. An eye & face fountain conforming to IS-10592 shall be provided in battery room, DM plant and chlorination Plant building.

Each toilet shall contain following min. fittings :

- Raised type 1 No. W.C. (Western pattern)
- Incase in a toilet block two or more WCs are provided one of the WC shall be Orissa type squatting WC.
- Urinals 2 Nos. (590x400x380)

  Urinals in Service & technical building in upper three floors and control room floors in Power House shall be
- Wash Basin 2 Nos. (550x440)
- Shower 1 No. for chlorination building/Control room area.
- Bathroom mirror 2 Nos. (600x450x5.5MM)
- Glass Shelves 2 Nos.
  (610mm x 127 mm x 6mm thk)
- Towel rail 1 No. 600x20mm dia CP Brass
- Liquid Soap Holder (stainless steel) 1 No.
- Toilet paper holder 1 No.
- Janitor 1 No.
- Water cooler RO system with 1 No.
- Septic tank including all accessories and laying of 150 mm or as per required dia. heavy cast iron soil lines.
- Effluent shall be treated through up flow filter system from septic tank and will pass through chlorination chamber before disposal to nearest area drain or through sewerage treatment plant as will be decided at the detail engineering stage.

10.00.00 **RULES AND BYE LAWS**

10.01.00 Statutory rules : a) Vendor shall comply with all applicable statutory rules pertaining to Factories Act as applicable for the State of Gujarat, Rules of Tariff Advisory Committee (TAC), Water Act for pollution control, Building by laws, Factory rules etc. of the State.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 600 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fire proof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. shall be made according to the recommend-ation of Tariff Advisory Committee.

11.00.00 LIST OF PRODUCTS TO BE USED IN THE BUILDING

Following products shall be provided for the project.

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
1.	Flush door (Solid Core)	Green Ply/ Century Ply wood	
2.	Laminates over flush door	Green Lam/Royal Challenge	
3.	Aluminium doors, windows and partitions	Extruded section of HIDALCO	
4.	Glass	Modi Float Glass for windows and Saint Gobins for partition, door and structural glazing.	
5.	Fire Door	Godrej or approved equal	
6.	Hydraulic Door Closer	Godrej or approved equal	
7.	Mortice Lock (heavy duty)	Godrej or approved equal	
8.	Floor Spring for Aluminium Door	Garnish/Godrej or approved equal	
9.	For seamless glazed door	Dorma/Ozone or approved equal	
10.	Non metallic Hardener	Sika Chapdor or approved equal	
11.	Ceramic Tiles	Euro/Johnson or approved equal	
12.	Vitrified tiles	Euro/Johnson or approved equal	
13.	PVC Soil and Waste water Pipe	Finolex/Supreme or approved equal	
14.	Western type water Closet	Hindware 20011+21001 or approved equal of Parry ware	White colour. For all buildings except Technical building and control room area
15.	Western type water closet	Hindware 20050+21033 or approved equal of Parry ware	Ivory colour for Technical building and Control room area
16.	Eastern type WC	Hindware 20042 with vitreous china flashing cistern or	White colour

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
		approved equal of Parry ware	
17.	Urinal	Hindware 6002 or approved equal of Parry ware	For all buildings except Technical building and Control room Floor. Division plate white marble 550x1000x20 mm thick.
18.	Urinal	Parry ware touch free with electronic flushing system	Ivory colour.
19.	Wash Basins	Parry ware 0487 or approved equal of Hindware	For all buildings except Technical building and Control room area
20.	Wash basins oval counter type.	Hindware counter top 10045 or approved equal of Parry ware	Ivory colour.
21.	CP Pillar tap	Centralhole basin mixer of Jaquar no. 5167 florentine quality	
22.	CP Angular stop cock	Jaquar no. 5053 florentine quality	
23.	CP Waste coupling for wash basin	32 mm dia. CP waste of Jaquar no. 709 (Allied Quality)	
24.	Bottle trap	CP bottle trap of Jaquar no. 769 (Allied Quality)	
25.	WC hand shower (Health faucet)	CP hand shower of Jaquar no. 573 (Allied Quality)	
26.	CP shower rose with arm and CP wall mixture with provision of shower	CP shower (Continental Quality) Jaquar no. 477&491 and wall mixture no. 5273 (Continental quality)	
27.	CP wall mounted soap tray	Jaquar no.1131 Continental quality	
28.	CP Towel rail	Jaquar no. 1111 Continental quality	
29.	CP Toilet Paper Holder	Jaquar no. 1151 Continental quality	
30.	Stainless steel Kitchen sink	Hindware no. S/135/240 or approved Equal	
31.	Wall mounted Sink Mixture	CP wall mounted Sink mixture of Jaquar no. 5309	
32.	Glass shelf	Jaquar no. 1171	Not required where counter top basin provided
33.	Robe Hook	Three prong robe hook of approved quality	
34.	Mirror	600x450 mirror of 6mm thick float glass of approved quality with backing	For all buildings.
35.	Mirror from basin counter top to bottom of false ceiling and full length of counter	6 mm thick mirror of float quality with backing.	For Technical Building and Control room floor.

Sl. No.	Name of the Product	Name of the manufacturer	Remarks
	Paintings		
36.	Acrylic Emulsion paint	Asian/ICI/Berger	Approved type and shade
37.	Acrylic washable distemper	Asian/ICI/Berger	Approved type and shade
38.	Acrylic exterior grade emulsion paint	Asian/ICI/Berger	Approved type and shade

12.00.00 **LIST OF FURNITURE TO BE PROVIDED IN SERVICE & TECHNICAL BUILDING AND CANTEEN BUILDING**

Following furniture of M/s Godrej interio make shall be provided in Service & Technical Building and Canteen Building

Name of the building	Description	Quantity	Manufacturer
Service and Technical Building	**Furniture**	**Each**	**Godrej**
Technical Staff	Workstation (Stallion) Rectangular Type. 69mm thick partition with dimension W 1200mm X D1 600mm X D2 750mm. Hight of workstation 1200mm.	56 nos.	Godrej
	Metal KBPT	56 nos.	
	CPU Trolley	56 nos.	
	3 DR NOVA Pedestal (646 x 390 x 435)	56 nos.	
	Chair - Spyder – PCH-9602A	56 nos.	Godrej
Supervisor's Room/Incharge Maintenance/ Engineers	Finesse Table 5630	14 nos.	Godrej
	Finesse ERU 3619	14 nos.	
	3 DR NOVA Pedestal (646 x 390 x 435)	14 nos.	
	Chair - Leoma – 9M02AX	14 nos.	Godrej
	Visitors' Chair - Leoma – 9M12AX	28 nos.	
Senior Manager	Meastro - Desk	4 nos.	Godrej
	Meastro - Mobile Pedestal	4 nos.	
	Meastro - ERU	4 nos.	
	Chair - Leoma – 9M02AX	4 nos.	Godrej
	Visitors' Chair - Leoma – 9M12AX	8 nos.	
Assistant GM Operation	Meastro - Desk	1 no.	Godrej
	Meastro - Mobile	1 no.	

Name of the building	Description	Quantity	Manufacturer
	Pedestal		
	Meastro - ERU	1 no.	
	Chair - Leoma – 9M02AX	1 no.	Godrej
	Visitors' Chair - Leoma – 9M12AX	2 nos.	
	Midas Sofa-L-52	1 no.	
	Corner Table Centre piece-530-1E	1 no.	
PA to AGM Operation	Finesse Table 4020	1 no.	
	Chair - Spyder – PCH-9602A	1 no.	
GM Operation	Jeferson Desk	1 no.	Godrej
	Jeferson ERU	1 no.	
	Jeferson Back Unit	1 no.	
	Chair - Eden HB Sim Leather & PU Arms + Bin	1 no.	Godrej
	Visitors' Chair - Eden Visitor Sim Leather & Silver metallic colour frame	2 nos.	
	Midas Sofa-L-53	2 nos.	
	Corner Table Centre piece-530-1E	2 nos.	
PA to GM Operation	Finesse Table 4020	1 no.	Godrej
	Chair - Spyder – PCH-9602A	1 no.	
Conference Room	Conference Table Talk Membrane 10 Seater Boat Convex	1 no.	Godrej
	Chair - Leoma – 9M01AX	10 nos.	Godrej
Seminar Room	Chair - 1512 DC	40 nos.	Godrej
	Finesse Table 4020	1 no.	
	Chair - Spyder – PCH-9602A	1 no.	
Library	KD Bookrack	10 nos.	Godrej
	Finesse Table 4020	1 no.	Godrej
	Chair - Spyder – PCH-9602A	1 no.	Godrej
	Reading Table-Versatila (V3)	1 no.	Godrej
	Staq Chair (without arm)	4 nos.	Godrej
Canteen Building			
Dining Hall	Cafe Table-Versatila (V4)	15 nos.	Godrej
	Staq Chair (with arm)	60 nos.	

VOLUME: IIG/3

TECHNICAL SPECIFICATION
FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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VOLUME: IIG/3 : TECHNICAL SPECIFICATION FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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TECHNICAL SPECIFICATION
FOR
I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

CONTENTS

I) LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

1.00.00 **SCOPE**

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutcha nullas, ditches, (with or without water), nearby roads/ approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north and the angle between the grid lines (established at site) and the true north or magnetic north shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent/near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans/maps.

The Plot Plan drawing gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased/ decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the contractor and plotted in his maps/drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job and handing them over to the Owner. It shall be responsibility of the Contractor to check the pillars jointly with Owner/ Engineer at the time of final handing over of the work to the Owner.

The tenderers should visit the project site, at his own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient knowledge about the site or for lack of clarifications on this specification.

2.00.00 GENERAL

2.01.00 Work to be Provided for by the Contractor

2.01.01 Work to be provided by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.

b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.

c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans/maps and drawings in specified scale incorporating sectional views and details as included under Section-1.0.

d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Information to be Submitted by the Tenderer

2.03.01 With Tender

The tenderer shall indicate in his tender the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that will be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed in the tenderer's offer which shall also include his present commitments.

2.03.02 After Award

The contractor shall inform and satisfy the Engineer regarding deployment of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner/Engineer and submit an agreed work programme within seven (7) days of award of the Work and during which period he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner/Engineer by the Contractor progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with Contractor's surveyor and engineer and point out the deficiencies/ discrepancies, if any, therein. However, the Contractor shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking/cross-checking as well as supervision during execution of the entire work, the Contractor shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner/ Engineer.

The Contractor shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.00.00 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.01.00 Instruments

The entire field surveying shall be done with the combination of transit/ optic Theodolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes and Plane Table Survey by Clinometer with the help of Clinograph Scale, ranging rods, etc.

Theodolite should be optically centered and the levels should be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the Contractor, will be preferred.

3.02.00 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement : two coarse sand : four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and reference grids shall be of mild steel, conforming to IS : 2062.

4.00.00 EXECUTION

4.01.00 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner/Engineer.

4.02.00 **Contour Intervals and Scale of Drawings**

4.02.01 **Contour Intervals**

For contouring, spot levels shall be taken at 10 m horizontal intervals or less in both directions to establish the contours at 300 mm intervals for nearly flat terrains and at 0.5 m to 1.0 m intervals for undulating hilly terrains, as per schedule of items and direction of the Owner/Engineer.

4.02.02 **Scale of Drawings**

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, as indicated in Schedule of Items, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.03.00 **Submission of Drawings and Documents**

The following documents shall be submitted to the Owner/Engineer :

4.03.01 Original field and level books and notes taken on special features, plus a photo-copy each of the above documents.

4.03.02 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner/Engineer. (One copy will be returned to the Contractor with comments, if any).

4.03.03 Original and one (1) copy of the above field drawings (item 4.03.2 above) after field verification of the comments and incorporating the corrected features.

4.03.04 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing/map shall be as per direction of Owner/ Engineer.

4.04.00 **Time of Completion**

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. : 4.03 above) shall be completed within a period of weeks/months in the following manner :

a) Mobilisation and firming up time schedule and survey groups ……week

b) Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.03.1 & 4.03.2 above). ... weeks

c) Submission of the final survey maps & drawings and other documents (item 4.03.1, 4.03.3 & 4.03.4 above). ... weeks

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within weeks of the clearance from Owner/ Engineer.

If the Owner/Engineer feels that the progress of the work is not satisfactory, he shall notify the Contractor to take necessary measures to complete the Work on time. If the Contractor fails to comply with the Owner's directive or fails to complete the Work on time, Owner will be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money/Security Deposit of the Contractor.

4.05.00 **Security Rules and Statutory Regulations**

The Contractor shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment/instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The Contractor, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner/Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The Contractor shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The Contractor shall give all notices and fees to be given or paid.

In respect of labour, the Contractor shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The Contractor shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the Contractor shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.00.00 TECHNICAL SPECIFICATIONS

5.01.00 Establishing of Bench Marks

At least two permanent bench marks at each site at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error should not be more than ± 05mm.

5.02.00 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.6. The maximum tolerance for any grid location shall be ± 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care should be taken that no magnetic substance to influence the bearing reading is there. The magnetic north should also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadestal map for establishing the new grid line and shall be related to true north line where grids are not existing.

5.03.00 Reference Grid Pillars and Bench Marks

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.04.00 Topographical Surveying and Mapping

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs/falls (if any) and other unusual ground formations/conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps :-

a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.
b) Levelling and plotting contours.
c) Surveying and locating the natural, artificial and permanent features in details as described earlier.
d) Taking of longitudinal and cross-sections of the corridors for pipe line and road/rail and drains, ditches, waterbodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.05.00 **Traversing and Ground Controls**

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points/ features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner/ Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object/reference grid pillar already existing at Site (as instructed by the Owner/Engineer).

The closing error in traverse (primary/secondary) shall not exceed one in three thousand in terms of length or, L $\sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.06.00 **Contouring**

Spot level surveying at specified intervals shall be adopted for contouring the area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.07.00 **Route Survey**

Route Survey shall be conducted along a narrow strip/belt of the terrain selected after field reconnaissance or as directed by Owner/Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat/undulating terrains and at 20 m intervals in hilly terrains, as per direction of the Owner/Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip/corridor shall be as specified in the drawing or as directed by Owner/Engineer.

TECHNICAL SPECIFICATION
FOR
II) GEO TECHNICAL INVESTIGATION

CONTENTS

II) GEOTECHNICAL INVESTIGATION

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The contractor shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, contractor's office, stores and protection of adjacent buildings, structures or services/facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his unit rates against the schedule of items.

2.01.00 Work to be provided for the Contractor

The work to be provided by the contractor, unless specified otherwise shall include but not be limited to the following.

a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervision by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the Owner/Engineer.

b) Locate in the field and in layout drawing all boreholes and other field investigation items.

c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification, schedule of items and instructions of the Owner/his Engineer.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Location and Levels**

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the contractor at his own cost from two reference grids and one bench mark given by the Owner/his Engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets/tables to be incorporated in the report by the contractor.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the contractor at no extra cost by the Owner.

2.04.00 **Codes and Standards**

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498	-	Classification and identification of soils for General Engineering purposes.
IS:1888	-	Method of load tests on soils
IS:1892	-	Subsurface investigation for foundation
IS:1904	-	Structural safety of buildings : shallow foundations
IS:2131	-	Method for standard penetration test for soils
IS:2132	-	Code of Practice for thin walled tube sampling of soils
IS:2720	-	Methods of tests for soils
IS:2809	-	Glossary of terms and symbols relating to Soil Engineering.
IS:2810	-	Glossary of terms relating to soil dynamics
IS:3025	-	Methods of sampling and testing for water used in industry
IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for in-situ vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation

IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
(Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
(Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009 (Part-I)	-	Calculation of settlement of foundations - shallow foundations subjected to symmetrical static vertical loads
(Part-II)		deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils

IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the contractor at the locations marked in the Geotechnical Test location plan prepared by the contractor and approved by the Owner / Engineer and/or at such other locations as directed by the Engineer in a manner described below.

Various methods of boring as described in IS:1892 may be adopted. The tenderer shall furnish in his tender the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. Incase rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The contractor shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the Engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the contractor shall have no claim whatsoever on this score. If the contractor can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The contractor shall use his own materials for this and the unit rate quoted shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the Owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the contractor using sand fill as and when directed by the Engineer.

3.01.00 **Stabilization of Boreholes**

Boreholes shall is stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.02.00 **Open Trial Pits**

The location of open trial pits shall be as shown in Geotechnical Test location plan and/or at such other locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The contractor shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the Engineer.

The contractor shall be paid at contract unit price for each trial pit which will include all costs for earthwork in excavation with necessary side slope and backfilling and shoring/sheeting for side protection, if required. If the pits exceed over 3.5m in depth, the contractor shall be paid at unit price for the extra depths of excavation.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the Engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.03.00 **Boring in River Bed**

For carrying out boring in river bed, the barge / boat should be properly anchored so that there is no movement of the platform due to waves which can cause damage to the drill rods and casing.

3.04.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall indicate in his tender the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock then by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the contractor shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the contractor shall determine nature of fractures and degree of weathering of rock for each bore hole. The contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The contractor shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer.

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is

weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the contractor shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).

b) IS:4078 - Code of Practice for indexing and storage of drill cores.

c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.05.00 **Adits and Test Shafts**

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for in-situ tests to determine the modulus of deformation of rock.

3.06.00 **Sampling**

Bored spoil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring, since it is intended to ascertain the characteristics of the soil at various depths. If, however, there is fair uniformity in the characteristics of the soil for certain depths the Engineer may limit the number of samples stipulated above.

3.06.01 **Tube Sampling**

For obtaining undisturbed samples in its simplest from, an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately on inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge of cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which

the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high, but not less than 50 mm dia. x 150 mm high.

Representative/disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.06.02 **Chunk Samples**

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.06.03 **Sampling in rock**

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.07.00 **Record of Boring**

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the Owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.

b) Personnel information - name of drilling contractor, driller and inspecting Engineer.

c) Equipment data - manufacturer's name and model designation.

d) Sampling and coring information

   i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.

   ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.

   iii) Push samplers : hydraulic pressure and rate of penetration.

   iv) Soil or rock coring : average rotational speed, downward hydraulic pressure and rate of penetration.

   v) Rock coring : Rock quality designation (R Q D)

e) Description of material penetrated but not sampled.

f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.

g) Seepage pressure test information-depth and duration of test.

h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.

i) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.

j) Elevation of top and bottom of hole and top of rock

k) Date and time of all operations and delays with reasons.

l) Miscellaneous information to aid interpretation of subsurface conditions.

m) Additional pertinent information.

The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the Engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the Engineer. The contractor shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Rammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetration shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00 Static Cone Penetration Test

The test shall be carried out at locations as shown on the drawing and/or at such other locations as directed by the Engineer. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec. unless otherwise instructed by the Engineer. The test shall be carried out upto a depth of ... m or upto the top of rock layer whichever is earlier.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The contractor shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 **Dynamic Cone Penetration Test**

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentonite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part - II. the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs depth.

5.00.00 **GROUNDWATER INVESTIGATION**

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 **Ground Water Level Observation**

The contractor shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the contractor during the period of investigation. At the end of the site investigation work, these boreholes shall be handed over to the Owner in such a condition that further observations can be taken by the Owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the Owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 **In-Situ Permeability Test**

In-situ permeability test shall be performed in the boreholes specified in Geotechnical Test location plan and/or at such other locations at specified

depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The contractor shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 **Pump-in Test**

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of prebored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored/discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02 **Pump-Out Test**

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 **FIELD TESTS**

In situ tests shall be performed as desired by the Engineer to measure properties of soil during the field investigation work.

6.01.00 **Menard Pressure meter Test**

This test shall be carried out as per clause 3.7 of IS:1892 in the..... bore holes specified in drg. no. ..... and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The tenderer shall furnish in his tender the complete details of the equipment and method he proposes to follow.

The contractor will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The contractor shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 **Direct Load Tests on Soils**

The direct load tests on soil shall be carried out in the trial pits specified in Geotechnical test location plan and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as indicated in the above drawing/as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm

square plate will be used in clayey soil and in sandy soils, three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of subgrade reaction and deformation modulus of soil.

The tenderer shall furnish in his tender the complete detail of the equipment and method he proposes to follow.

The excavation and side protection during the test and back- filling after the test shall be carried out by the contractor. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the contractor.

The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The contractor must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level & staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the contractor shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

The payment shall be lumpsum for each test & shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m extra payments shall be made only for earthwork and shoring, if any. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the contractor himself. All expenses in this connection shall be included in his quoted rates.

6.03.00 **Vane shear Tests**

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the Engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 **Determination of Dry-Density of Soils**

In place dry density of soil is required for assessment of bearing capacity of soils, analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the Engineer for determination of in-place dry density of soils.

6.04.01 **Sand Replacement Method**

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02 **Core-cutter Method**

The specification for this test shall be as per IS:2720 (Part XXIX) . The method should be applied for fine grained soil, free from aggregates . Fine grained soils for the purpose of application of this method are defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 **Ring and Water Replacement Method**

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 **Rubber balloon Method**

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV) . This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 **In-situ Block Shear/Wedge Shear Test**

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The tenderer shall furnish in his tender the complete detail of the equipment and the method he proposes to follow.

The test shall be carried out in the trial pits marked in Geotechnical test location plan. and/or at such other locations as directed by the Engineer. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

The payment terms as indicated for clause 3.02.00 above shall hold good for this test.

6.06.00 **Test for Measurement of soil Resistivity**

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing S = 5, 10, 15, 20 metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V, between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes, then the soil resistivity.

= 2 X 3.14 X S.V / I

Where, Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

I = Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement, above formula becomes

= 2 X 3.14 X S.R.

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 or the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The Tenderer shall furnish in his tender the complete details of the equipment and method of testing he proposes to follow.

The locations at which such tests are to be carried out are indicated in Geotechnical test location plan and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.
The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The contractor will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The payment shall be lumpsum for each test and shall include all costs inclusive of earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 Block Vibration Test

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

a) Vertical Vibration Test

b) Longitudinal Horizontal Vibration Test

c) Free Vertical Vibration Test

d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS:1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The contractor must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The contractor shall bring not less than two dial gauges and one pressure gauge as standby.

The contractor shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the contractor shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the contractor shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 **FIELD DETERMINATION OF CALIFORNIA BEARING RATIO**

The test shall be carried out at locations as shown on the drawing or at locations as directed by the Engineer. The test shall be carried out at a depth of 500 mm below the finished ground level.

The contractor shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the contractor shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free

water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down is IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES/ROCK CORES

The contractor shall carry out the tests as listed out in the Schedule of Items, and/or as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The Owner shall have the right of access to contractor's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labeled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

10.01.00 General

a) On completion of all the field and laboratory work, the contractor shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include

detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the contractor shall submit ----- copies of the report in draft form for the Owner's review.

b) The contractor's qualified geotechnical Engineer shall visit the Owner's corporate office for a detailed discussion on the Owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the contractor shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducible of the graphs, tables, etc.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The contractor shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 **Data to be furnished**

The report shall include the enlisted items but not be limited to them.

a) Purpose and scope of investigation

b) Authorization enabling the contractor to carry out the work at the site.

c) Project description including proposed facilities and construction materials required for the works.

d) Description of the site which shall include

i) Location of the site and existing facilities.

ii) Topography of the site

iii) Drainage Characteristics

e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.

f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.

g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.

h) **Geological information**

i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.

ii) Description of overburden and bedrock at the site (if applicable for the site)

iii) Comments on texture & structure of rock, joints, bedding planes, fissures, weathering condition etc. (of applicable for the site)

iv) Effect of geologic features on design.

i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.

j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.

k) Plot of SPT (N) value (both uncorrected and corrected) with depth.

l) Procedure of investigations employed - field tests and laboratory investigation.

m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

n) For all triaxial shear tests stress vs strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity E shall be furnished for all tests along with relevant calculations.

o) For all consolidation tests, the following curves shall be furnished:

e vs log p

e vs p and

compression vs log t or

Compression vs square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

q) For pressure meter tests, the following curves shall be furnished:

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.

r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 **Recommendations**

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following :

a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.

b) For shallow foundations, the following shall be indicated with comprehensive supporting calculations :

i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.

iii) Rate and magnitude of settlement expected of the structure.

iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results alongwith

time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.

c) If piling is envisaged, the following shall be indicated with comprehensive supporting calculations.

i) Type of pile and reasons for recommending the same considering soil characteristics.

ii) Suitable founding strata for pile.

iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.

iv) Magnitude of negative skin friction, if any, to be considered in pile design.

d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.

e) Recommendations regarding bases of roads and pavements.

10.04.00 **Additional Recommendations**

a) Coefficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.

c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.

e) Coefficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.

f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.

g) Recommendations regarding method and slope of deep excavations.

h) Recommendations regarding stability of slopes, during excavations, etc.

i) Potential of rock slides and methods of stabilisation of slides for very steep cut.

j) If expansive soil is met with recommendation on removal or retainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.

k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.

l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.

m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub-structures and also recommended protective measures, if required.

n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.

o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits/trenches.

p) Recommendation on the use of rock available as construction material.

q) Recommendation on the availability of material for use as aggregates at the site.

r) Recommendation for additional investigation beyond the scope of the present work if the contractor considers it necessary.

s) **Plates**

i) General plan showing location of site, and area geology.
ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
iii) Geologic sections and soil profiles.

t) **Appendices**

i) Logs of subsurface explorations
ii) Field test results
iii) Laboratory test results.

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

CONTENTS

PART-A

TECHNICAL SPECIFICATION - GENERAL

CONTENTS

PART-A

TECHNICAL SPECIFICATION - GENERAL

1.00.00 SCOPE OF WORK

The work to be performed under the scope of this specification consists of design, supply and construction of the following work.

This scope of work is to be considered in addition to the scope of work outlined in clause 2.00.00 of K9213-EPC-SPC-001 Volume IIG/1.

a) Clearing and grubbing areas for Area Grading and land filling, cutting trees, bushes etc. including taking out roots.

b) Area grading work including excavation, dressing and leveling as per grades shown in tender drawing annexed hereto.

c) Land filling with selected earth from excavation and from areas designated by owner and or from borrow pits arranged by the Contractor. The present grade level shall be raised upto RL 72 M (above MSL) filling with selected earth and or suitable granular fill material.

d) Earth work for embankment and temporary roads for construction.

e) Slope protection for embankment and sides of filled-up area within the plot designated for Unit 8 Expansion. This work shall also include design of slope protection work using geo-synthetic lining system and lining the sloped surface for protection against erosion.

The major area of work will be primarily within the plant boundary including areas for Unit 8 Expansion. Nature and extent of the work has been given on the Tender drawing annexed hereto but those are preliminary only and are by no means complete and are subject to change. Design drawing showing complete nature of work will be furnished to the Contractor progressively during execution of the work. Contractor shall develop detail drawings for construction and submit the same for approval.

The supply, design and construction of Geo-synthetic/Geo-textile lining system with protective earth cover and turfing (or precast concrete blocks/Brick tiles) shall be under the scope of Contractor. The design of Geo-synthetic lining system shall be done by approved manufacturer or specialized agencies and to be submitted to owner for approval. Laying of Geo-textile grid and covering the same with soil shall be done by the agencies specialized for this type of work.

All items of work shall be executed in accordance with the relevant specifications annexed hereto and the provisions of the contract.

The work to be performed under this tender specification consists of providing all labour, supervision, materials, scaffoldings, construction equipment, tools

& plants, supplies, transportation, all incidental items not shown or specified, but reasonably implied or necessary for successful completion of the work including Contractor's supervision and in strict accordance with the drawings, specifications.

Tenderers are not generally expected to stipulate any conditions of their own or deviate from the General & Supplementary Conditions of the Contract and Specifications. However, should it become necessary, all such deviations shall be indicated clause wise in a separate schedule. Deviations mentioned or brought out elsewhere in the tender other than in the above schedule, will not be entertained and such offers which do not conform to the above requirements are liable to be summarily rejected.

The requirements and the Conditions of Contract as stated in General and Special Conditions of Contract by GSECL are also applicable.

2.00.00 DESCRIPTION AND FEATURES OF THE SITE

2.01.00 The work specified herein shall be carried out at Wanakbori Power Plant, Gujarat, within the area designated for 1x800 MW Super Critical Thermal Power Plant Extension Unit.

2.02.00 The Power Plant is located at Wanakbori, Kheda District in the State of Gujarat.

2.03.00 **Location of Power Plant**

i) At Wanakbori TPS, Kheda District, Gujarat.

ii)	Nearest Town	:	Balasinor (13 Km from Site), Sevalia (10 Km from Site)
iii)	Nearest Highway	:	NH-08 (10 Km from Site)
iv)	Nearest Railway Station	:	Sevalia (8 Km from Site)
v)	Nearest Airports	:	Ahmedabad (110 Km from Site) Vadodara (85 Km from Site)

2.04.00 **Meteorological Data**

Weather data for the site :

a)	Dry bulb temperature (max. & min.)	:	40.8^{o}C & 10.8^{o}C
b)	Humidity (min. & max.)	:	42.5% to 81.5%
c)	Average Annual Rainfall	:	750 mm
d)	Wind speed	:	Basic wind speed of 39 m/sec as per IS-875 (Part-3).
e)	Seismic zone	:	Zone-III as per IS-1893

3.00.00 SOIL CHARACTERISTICS

Boring and subsurface data regarding nature of soil, subsoil water etc. are not available now. The tenderer shall satisfy himself of the character and volume of work under the items and expected surface and/or subsoil water to be encountered. He must satisfy himself about general conditions of the site and ascertain the existing and future obstructions likely to come up during the execution of the contract to carry out work under this scope.

[Geo-technical investigation work for preparatory work is being done by other agencies. The report will be available with GSECL after completion of work]

4.00.00 SPECIFICATIONS

The following Technical Specifications are to be referred for various items of work:

A) Technical Specification for Area Grading and Slope Protection

B) Technical Specification for Geo-textile Fabric.

The above specifications are intended for the General description of quality, workmanship etc. desired for various items of work under the Contract. The Specifications are not, however, intended to cover minutest details and all work shall be executed according to the spirit of the specifications and in absence thereof, according to the relevant latest Indian Standard Specification. In absence of the latter, the work shall be executed according to the best prevailing local Public Works Department Practice or to the recommendations of the American or British Standard Specifications at the discretion of the Engineer.

5.00.00 DRAWINGS

The following tender drawings are to be referred in relation to Area grading and Slope Protection work.

Sl. No.	Drawing No.	Description
1.	K9213R-DWG-S-0002 REV 8	Area Grading Plan & Sections
2.	K9213R-DWG-S-0008 REV 0	Paving Pattern For Slope Protection
3.	-	Contour Plan dtd MAY 2010.
4.	K9213R-DWG-M-002, Rev 4	Plot Plan – Unit # 8

Aforesaid drawings are preliminary for Tender purposes only and are by no means complete and final and do not show the full range of the work under the scope of the Contract. Work shall be carried out only on the basis of

design drawings marked "Released for Construction" with additions, alterations and modifications made to aforesaid drawings from time to time and also according to detail construction drawings that will be prepared by the Contractor progressively during the execution of the work.

The Contractor shall refer to the Engineer any discrepancy which may exist between the drawings and the specification for clarification. Engineer's decision as to the clarification of the point raised shall be final and binding to the Contractor.

6.00.00 LAYOUT

The layout and levels of all the work shall be made by the Contractor at his own cost from the general grid of the plot and bench marks given by the Engineer. He shall give all help with instruments, materials and men to the Engineer for checking the detailed layout and correctness of the layout and levels. The approval of the Engineer shall not be deemed to imply any warranty and shall not relieve the Contractor of his sole responsibility in connection with carrying out the work correctly.

Making bench mark pillars and reference line pillars etc. and maintaining them upto the completion of the work shall be responsibility of the Contractor. No extra payment shall be made on this account.

7.00.00 WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. In addition to the requirement specified above, if the bye-laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and

re-erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

Owner is not bound to supply materials (cement, reinforcing steel & structural steel) for such temporary work. However, depending on merit of the situation and also discretion of the Engineer, the material may be issued to the Contractor, subject to the availability of the same. The materials issued for this purpose shall be treated as bonafide consumption and will be recovered at issue price as stipulated in Special Condition of Contract.

9.00.00 **TENDER DRAWINGS (Refer Volume IIL of Specification)**

PART-B

TECHNICAL SPECIFICATION
FOR
III) AREA GRADING AND SLOPE PROTECTION

CONTENTS

SECTION-II

TECHNICAL SPECIFICATION FOR A) AREA GRADING AND SLOPE PROTECTION

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, blasting (if required), hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for subgrade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof. For hauling of earth from approved borrow areas to site, agency shall get timely approval from all statutory authorities for right of way. GSECL will give recommendation letter to obtain the permission from appropriate authority for excavation from borrow area.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing, slope protection work etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

However, the Owner reserves the right to award the whole work to one Contractor or to split up the work for awarding to two or more Contractors.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry Relation using Light compaction
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry Relation using Heavy Compaction
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative Density) of cohesion less soils
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place, by core cutter method
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils, in place, by sand replacement methods
IS : 3764	:	Safety Code for Excavation Work
IS : 4081	:	Blasting and related drilling operations
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work.

2.04.00 **Conformity with Designs**

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material.

When specific borrow area can not be designated by the Engineer, necessary arrangement shall be done by the Contractor at his own cost for locating and using the borrow areas as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic Surveys

ii) Establishment of markers, Boards etc.

iii) Checking levels and slopes of the graded surface.

b) Area filling :

i) Checking the quality of fill material

ii) Checking moisture content of the fill

iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications will be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection will be reviewed in accordance with the site Quality Plan.

2.07.00 **Information regarding Site Conditions**

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **General**

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the contractor. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Engineer. Adequate area lighting shall be provided by the contractor, if night work is undertaken.

The Contractor shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Engineer. The proposal shall include but not be limited to the following:

a) Mobilisation and demobilisation of plant

b) Proposed plant and equipment, labour resources & supervision.

c) Details of proposed method of clearing and grubbing for each area of cut and fill.

d) Drawings showing the areas for placement of material.

e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.

f) Temporary works proposals

g) Excavation, filling and compaction by mechanical plant

h) Dealing with surface water

i) Dewatering

j) Disposal of materials

k) Safety precautions, fencing and lighting

l) Calculations as appropriate to support work proposal.

3.02.00 **Setting Out**

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor at his own cost.

3.03.00 **Initial Levels**

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. These initial levels and cross-sections shall be jointly signed by the Contractor and the Engineer before commencement of work and they shall form the basis of all payment in future.

3.04.00 **Clearing and Grubbing etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300 mm girth shall be uprooted. Trees of all sizes are required to be cut and transported to owner’s store. Also all serviceable materials to be credited at owner’s store. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot-holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.05.00 **Classification**

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor :

a) Ordinary and hard soil

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) Soft and Decomposed Rock

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction.

The mere fact that the contractor resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock. Excavation in macadam and tarred roads and pathways, brick work etc. shall be considered at the same rate as excavation of this type of soil.

c) Hard Rock

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be measured under this item, unless a separate provision is made in the schedule of Quantities for the same.

3.06.00 Earthwork in Excavation

3.06.01 General

Before commencement of excavation the existing ground surface shall be cleared in accordance with Clause no. 3.04.00.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted in accordance with the specification as specified in Clause No. 3.07.01.

3.06.02 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly & the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.06.03 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

3.06.04 Blasting

3.06.04.01 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting license from the authorities concerned.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such license, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies / regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 10. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.06.04.02 Material

All materials such as explosives, detonators, fuses tamping materials etc. are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds or inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.

The detonators used shall be capable of giving an effective blasting of the explosives, moist; and damaged detonators shall be discarded.

3.06.04.03 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules. Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Persons entering the magazine, must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful :

- Not to put their feet on the clean floor unless they have the magazine shoes on.

- Not to allow the magazine shoes to touch the ground outside the clean floor.

- Not to allow any dirty or grit to fall on the clean floor.

Persons with bare feet, shall before entering the magazine dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine, on each occasion if it is opened for the receipt, delivery or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100 m of a magazine.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.06.04.04 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.06.04.05 Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully and shall compare the number of blasts planted/fired to the actual number of shorts heard and satisfy himself that all blast have exploded. Withdrawal unexploded charges shall not be permitted. The unexploded charges shall be flooded with water and the hole shall be marked in a distinguishable manner. Another hole shall be made by drilling a parallel fresh hole not less than 450 mm from misfired hole and fired in the usual way. The process shall be continued till the original blast is exploded. The engineer shall also be informed by the Contractor of all the cases of misfired/unexploded charges, their causes and steps taken. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.06.05 Disposal

The excavated spoils will be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Engineer :

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) By either spreading

or

ii) Spreading and compacting at designated filling areas and/or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back-filling or other purposes by some other agency.

e) Disposal of debris, earth, mill rejects, (if not useful) excavated spoils will be disposed off outside plant area by bidder. Disposal area shall be identified by the bidders.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.06.06 Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area without any extra cost. Method of dewatering shall be got approved by the Engineer.

3.06.07 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.07.00 **Treatment of Slips**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and backfilled later by him at his own expenses.

3.08.00 **Earthwork in Filling**

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated/approved by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed of as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 200 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Engineer.

a) Each layer of earth of cohesive nature shall be compacted to 90% of proctors dry density unless otherwise permitted/directed by the Engineer.

b) Each layer of earth of non-cohesive nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Engineer.

Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Engineer. The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tonne roller.

i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

The cohesionless soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation

moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the contractor's cost as directed by the Engineer. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the contractor's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling, will be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer. All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer. No payment for compaction shall be made for such nominal compaction.

3.09.00 **Compaction Control**

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Contractor in accordance with these specifications at the Contractor's expense and as directed by the Engineer.

The Contractor shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle. He shall also supply all

consumable materials such as kerosene, spirit, gas and sample bags as required.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Contractor is to obtain the Engineer's approval for the firm to be used. The Contractor may undertake this work with the Engineer's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Engineer based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The contractor shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Engineer.

3.10.00 Protection of Side Slopes

The side slopes of the embankment shall be protected against slippage caused by rain cuts, erosion by wind etc. The surface treatment to be adopted will be by turfing, by lining, or by other means as shown in the drawings and also as directed by the Engineer.

3.10.01 Turfing

3.10.01.01 General

The provision of turfing involves the plantation of grass on the top and/or side slopes of the embankment as shown on the drawing or as directed by the Engineer. The work of turfing shall be taken up immediately after the construction of embankment, provided the season is favourable for the establishment of sod, preferably well before monsoon, but not during the monsoon.

The sod shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality. Thickness of sod shall be between 5cm & 8cm, so that all the dense root system is retained in the sod strip. The sods shall be of rectangular strips of uniform width, not less than about 25cm x 30cm in size but not so large that it is inconvenient to handle. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather shall be watered before lifting to ensure its vitality.

3.10.01.02 Preparation of Bed

After the embankment has been constructed to shape and well compacted, the surface earth shall be loosened to a depth of 75 mm for receiving the sod. If the soil is not suitable for grass growth, suitable top soil shall be spread over the slopes and worked into the already loosened soil. Where required, fertilizer shall be spread and incorporated in the soil.

3.10.01.03 Placing of Sod

The prepared sod bed shall be moistened to the loosened depth and the sod shall be placed within 24 hours after the same has been cut. Each sod strip shall be placed edge to edge and such that the joints caused by abutting ends are staggered. The sod shall be lightly tamped with wooden or metal tampers to press it into the underlying soil. The strips are to be placed on the prepared embankment surfaces starting at the bottom. When the top is reached, the edge of the sod shall be turned into the surface and a thin layer of earth placed over the edge and compacted so as to divert water above the edge onto the top of the sod.

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2 metres, the sod shall be staked with pegs or nails spaced approximately 50 to 100 cm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them.

The sods shall be watered until the seeds or roots have sprouted. The preferable system of watering is by spraying rather than by flowing.

3.10.02 Geo-textile Membrane

Refer Volume IIG/3 Section XXXII for Technical Specification.

3.10.03 Earth/Soil

The excavated soil, selectively taken from the stacks of the same Contractor and/or stacks left by other agencies shall be used for covering geo-textile membrane and shall be free from pebbles, stones, vegetation and sieved to segregate stones, etc. present in it, if directed by the Engineer. The minimum clay-content of this soil shall be 25%. No fine sand layer excavated shall be used as cover over films.

3.10.04 Pre-cast Concrete

Ingredients used in pre-cast concrete blocks (to be used for covering geo-synthetic/geo-textile membrane) shall conform to the relevant provisions in IS:456, latest revision.

All precast work shall be carried out in a yard made for the purpose. This yard shall be dry properly levelled and having a hard and even surface. If the ground is to be used as a soffit form of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:3 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after installation.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper installation of the precast units. All minor defects shall be touched up with a paste of 1 part cement and 3 parts sand.

3.10.05 Bricks and Brick Tiles

Bricks and brick tiles shall be of first class (class A) quality, well burnt, of uniform size, shape and colour, free from cracks, flaws or nodules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, holes etc. compressive strengths shall be 50 Kg/sq.cm minimum for common bricks. Water absorption after 24 hours immersion shall not exceed 15% by weight for common bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

If the Tenderer can not arrange for such quality bricks during execution, he should clearly indicate it in his offer. Samples of bricks/brick tiles have to be got approved by the Engineer. Any brick or consignment of bricks not found upto the specification shall be outright rejected and shall be removed immediately from site at the Contractor's own cost.

3.10.06 Execution of Slope Protection

The Work shall be strictly executed according to the provisions of this specification, final drawings to be issued, instructions of the Engineer at site, and/or catalogues of the approved manufacturer of Geo-textile membrane films.

3.10.06.01 Preparation of Sub-grade

The side slope shall be well compacted and free from undulations. All sharp objects such as rock pieces, boulders, stones, pebbles, roots and weeds shall be cleared to prevent puncturing of the membrane, and holes are to be filled up with proper material and compacted as directed by the Engineer. If the sides of excavation is a rock-cut terrain, sharp protrusions shall be levelled off. It is important that the sloping sides are well compacted to the satisfaction of the Engineer.

3.10.06.02 Treatment of Weed- Infested Areas

For safe guarding Geo-textile membrane against the growth of weeds, weedicides (such as Biodex-C, Grammaxene, Fernoxene or equivalent products) should be mixed with water in accordance with the manufacturer's instructions (3 litres of weedicide mixed with 200 litres of water is a standard practice) and this solution should be spread over the earth with a chemical spraying pump on side slopes.

The anti-weed treatment should be given only after moisture content of the soil is brought below 29%. After completion of the spraying of anti-weed chemicals and before taking up the next activity, a period of 24 hours should be allowed for penetration of the chemical into the soil.

3.10.06.03 Anti-Termite Treatment

The danger of termites at the side slope is rather remote. However in the case of infested areas, suitable insecticide slurries with insecticides such as BHC may be used over the side slope and before laying the film to prevent termite attack.

The tenderer, in his offer, shall quote separately for spraying suitable insecticide slurries in each square metre of treated area, and shall clearly indicate the type of insecticide, he proposes to use, manufacturer's name, proportion of ingredients in the slurry, and method of application, etc.

3.10.06.04 Not used.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

The following tests shall be undertaken by the Contractor and results and reports shall be submitted to the Engineer for approval. Test failures are to be immediately notified to the Engineer, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction. Each layer is to be tested in a manner that is representative of its full depth. The Engineer may at his discretion instruct the Contractor to increase or decrease the frequency of testing.

a) Minimum one test per 500 cu.m of soil coming out of the borrow pits for determination of natural moisture contents in order to evaluate how far the natural moisture content tallies with the optimum value and whether further addition or reduction of water content would be necessary. Test to be done in accordance with IS : 2720 (Part-II).

b) Minimum two sets of laboratory tests per 8000 cu.m of soil coming out of the borrow pits for determination of dry density at optimum moisture content. Test to be done in accordance with IS : 2720 (Part-VII, XIV, XXVIII, XXIV) as applicable.

c) Minimum two sets of test per 500 cu.m of loose fill for determination of moisture content just prior to compaction of area filling. Test to be done in accordance with IS : 2720 (Part-II).

d) For each compacted layer, minimum one test per 2000 sq.m of compacted area for determination of moisture content and dry density.

e) Minimum two tests per 8000 cu.m of soil for determination of soil classification. Test to be done in accordance with IS : 2720 (Part-IV).

f) Minimum 10 (ten) density measurements shall be plotted to establish moisture content-dry density relationship.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.

The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth, at the Contractor's cost.

Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender :

i) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.01.00 (i) above.

iii) Method of transportation.

5.02.00 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption :

a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area- filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
IV) EARTHWORK IN EXCAVATION AND BACKFILLING

CONTENTS

IV) EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS:1200 : Method of Measurement of Building and Civil (Part-I) Engineering work; Part-I Earthwork.

IS:2720	:	Determination of Moisture Content (Part-II).
IS:2720	:	Determination of Moisture content/Dry Relation (Part-VII) using Light Compaction.
IS:2720	:	Determination of Density Index (Relative Density) (Part-xiv) of cohesionless soils.
IS:2720	:	Determination of Dry Density, in place, by core (Part-xxix) cutter method.
IS:2720 (xxviii)	:	Determination of Dry Density of soils, in place, (Part-by sand replacement methods.
IS:3764	:	Safety code for Excavation work.
IS:4081	:	Blasting and Related Drilling Operations
IS:4701	:	Earthwork on canals

2.04.00 **Conformity with Designs**

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.05.02 **Borrow Material**

Borrow material required for back-filling shall be excavated from approved locations & levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

2.06.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution.

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :

i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling :

i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction.

2.07.00 **Information regarding site conditions**

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation there from shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, Sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 **EXECUTION**

3.01.00 **Setting Out**

Within 7 days of releasing of construction drawing, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.02.00 **Initial Levels**

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made there from, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.03.00 **Clearing and Grubbing, etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.04.00 **Classification**

All earthwork shall be classified under the following categories :
No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

iv) Rock cutting and blasting, if required.

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 **Excavation for Foundations and Trenches**

3.05.01 **General**

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even

below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those over cuts which are unavoidable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this over cut is not due to negligence of the Contractor. The decision of the Engineer as to the admissibility of such over cut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.05.02 **Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 meters, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiseling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

3.05.04 **Blasting**

3.05.04.1 **General**

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.05.04.2 **Storage of Explosive**

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedge etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.05.04.3 **Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.05.04.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

When blasting is conducted in the neighborhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.05.05 **Disposal**

The excavated spoils will be disposed of in any or all the following manners :

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or
ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately and shall be measured in stacks deducting 30% volumetric measure for voids.

3.05.07 **Protection**

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

All the above works shall be carried out by the Contractor without any commercial implication to the Owner.

3.05.08 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.05.09 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water & subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such de-watering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment & measurement, provided the Contractor has completed all the work satisfactorily.

3.05.10 **Timber Shoring**

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250x40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal

walers of strong wood at maximum 1.2 metres spacings, cross strutted with bellies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of Silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel

shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 **Filling in Disposal Area**

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 **Approaches and Fencing**

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 **Lighting**

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 **TESTING AND ACCEPTANCE CRITERIA**

4.01.00 **Excavation**

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer, at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 **Back-filling**

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-vii) or a relative density of 75% as per IS-2720 (Part-xiv) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 **INFORMATION TO BE SUBMITTED**

5.01.00 **With Tender**

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.02.00 **After Award**

After award of the Contract the successful tenderer shall submit the following for approval and adoption :

a) Within 30 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures. In case the Earthwork Contractor is also the agency for the foundation work, the Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

TECHNICAL SPECIFICATION
FOR
V) CEMENT CONCRETE – PLAIN AND REINFORCED

CONTENTS

V) CEMENT CONCRETE - PLAIN AND REINFORCED

1.00.00 **SCOPE**

1.01.00 **General**

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 **GENERAL**

2.01.00 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following :

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

I) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and Schedule of Items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 **Work by Others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 **With Tender**

The following technical information are required with the tender :

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award**

The following information and data including samples where necessary, shall be submitted by the Contractor progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Approval of such programme shall bind the Contractor to adherence and assurance of their duties and responsibilities according to agreed schedule.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

Contractor shall furnish daily/weekly progress of work and details as may be required by Owner so as to enable him to monitor the progress of work. The Contractor shall submit the progress photograph in three (3) copies every month relating to the progress of work in sequence for major activities.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :

i) Coarse and fine aggregates.
ii) Admixtures.
iii) Plywood for Formwork.
iv) Embedded and anchorage materials as may be desired by the Engineer.
v) Joint sealing strips and other waterproofing materials.
vi) Joint filling compounds.
vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works. Before submission to the Engineer, the design mix needs to be approved from recognized institution.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b) and 3.16.1 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (c).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (e).

g) Mill Test Reports for Cement & Reinforcing Steel

Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.04 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of

all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 **Cement**

Generally cement shall be 43 grade / 53 grade ordinary Portland Cement conforming to IS-8112 / IS 12269. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 33 Grade ordinary Portland Cement conforming to IS-269

b) Rapid hardening Portland Cement conforming to IS-8041

c) Portland slag cement conforming to IS-455

d) Portland Pozzolona Cement (fly ash based) Conforming to IS-1489 (Part-1)

e) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)

f) Hydrophobic Cement conforming to IS-8043

g) Low heat Portland Cement conforming to IS : 12600

h) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 **Aggregates**

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75mm & 150mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases, the preferred zone is Zone-II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer.

2.05.04 **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-I of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS-4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 **Admixture**

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards :

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete

or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or approved equivalent.

b) Retarding admixtures :

Modified ligno sulphonate based set retarding concrete admixture like, "Plastiment R" or approved equivalent.

c) Water reducing admixtures :

Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or approved equivalent.

d) Air entraining admixtures :

Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP" or surface - active agents like "Sika AER" or approved equivalent.

e) Water proofing admixtures :

Modified lingo-sulphonate based waterproofing admixture like "Plastocrete Super" or approved equivalent.

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer :

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value, infra red analysis & solid content).

2.05.06 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stackwise) of all materials. Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the type & different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

Grading of aggregate shall be checked by the Engineer in conformity with respective IS Code and the design requirement and if the same is found not meeting the above requirement the material will be replaced by the Contractor at his own cost.

2.06.04 **Reinforcement**

Reinforcing steel shall be stored consignment-wise and sizewise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 **Quality Control**

The Contractor shall submit the Quality Assurance Plan (QAP) for total work to the Owner/Engineer for approval and follow the approved plan during work execution. Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work :

a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
b)	Aggregate	:	Physical, chemical & mineralogical qualities, Grading, moisture content and impurities.
c)	Water	:	Impurities tests.
d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Spec. (If Contractor's supply).
g)	Grades of concrete	:	Usage & mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.

i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, the limitations, time intervals between mixing & placing and between two successive lifts, covering over dry or wet surfaces, cleaning & preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency & amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 **Admixture**

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 **Grades of Concrete**

Concrete shall be in any of the grades designated in IS:456. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 will be followed.

3.04.00 **Proportioning and Works Control**

3.04.01 **General**

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 **Mix Design Criteria**

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations :

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables in the specification are included. For identical condition if values given in the tables shown herein below are different from those mentioned in IS:456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE-I

STRENGTH REQUIREMENT OF CONCRETE

	Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)
M-10	10
M-15	15
M-20	20
M-25	25
M-30	30
M-35	35
M-40	40

Note-1 : Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. These mixes need not be designed.

Note-2 : Grades of concrete lower than M-20 shall not be used in reinforced concrete.

TABLE-II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO

(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm size	**38 mm size**	**20 mm size**	**38 mm size**
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-175 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

NOTE-1 : Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

NOTE-2 : It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

NOTE-3 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 **Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per strength and durability requirement conforming to IS 456 : 2000 and design mix criteria.

3.07.00 **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on

a) The requirement of strength.

b) The requirement of durability.

3.07.01 **Strength Requirement**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.07.02 **Durability Requirement**

Tables 3,4 & 5 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in Table No. IV.

In general the water cement ratio between 0.4 & 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer.

However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

TABLE-IV

MAXIMUM PERMISSIBLE WATER/CEMENT RATIOS FROM DURABILITY CONSIDERATIONS FOR DIFFERENT TYPES OF STRUCTURES AND DEGREES OF EXPOSURE USING ORDINARY PORTLAND CEMENT

Type of Structure	**Exposure Conditions**			
	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	**In Air** In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Thin sections such as railings kerbs, sills ledges, ornamental or Architectural concrete reinforced concrete piles, pipes and all sections with less than 25mm concrete cover to reinforcement.	0.49 0.44	0.40	0.53 0.49	0.40
Moderate sections such as Retaining Walls, abutments, piers, girders, beams	0.53 0.49	0.40	* 0.53	0.44
Exterior portions of heavy mass sections.	0.58 0.49	0.44	* 0.53	0.44
Concrete deposited by Tremie under water	- 0.44	0.44	- 0.44	0.44

Type of Structure	Exposure Conditions			
	Severe wide range of temperature. Frequent alterations of freezing & thawing (use Airor arid Entrained concrete only)		Mild Temperature rarely below freezing or rainy	
	At the water line or within the range of fluctuating water level or spray		At the water line or within the range of fluctuating water level or spray.	
	In Air		**In Air**	
	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)	In Fresh Water	In sea water or in contact with sulphate (concentration more than 0.2 p.c)
Concrete slabs laid on ground	0.53 -	-	* -	-
Concrete which will later be protected by enclosure or backfill but which may be exposed to freezing & thawing for several years before such protection is offered.	0.53 -	-	*	
Concrete protected from the water, interiors of buildings, concrete below ground which is free from sulphate attacks.	*		*	

Note: * Water/Cement ratios should be selected on basis of strength & workability requirements.

3.08.00 **Workability**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE-V

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199 and Clause 7 of IS 456:2000 shall be carried out.

3.09.00 **Size of Coarse Aggregates**

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer :

Very narrow space	-	12 mm
Reinforced concrete except foundation	-	20/12 mm
Ordinary Plain concrete and Reinforced concrete foundations	-	40/20 mm
Mass concrete	-	80/40 mm
Mass concrete in very large structure	-	150/80 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within ± 2% of the quantity of Cement, water or total aggregates being measured and within ± 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.

3.11.00 **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying with required consistency and plasticity without loss of slump and as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, inspite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 **Placing and Compacting Concrete**

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces :

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 **Construction Joints and Cold Joints**

3.13.01 **Construction Joints**

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods & equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the location of the joints are not specified, it will be in accordance with the following :

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 **Cold Joint**

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12-24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Cl. 3.12.

3.14.00 **Repairs, Finishes and Treatment of Concrete surfaces**

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the enforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with a cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 **Finishing Unformed Surface**

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the

approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 **Protection and Curing of Concrete**

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet , hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

3.16.00 **Reinforcement**

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077 , as shown on the drawing or as directed by the Engineer.

3.16.01 **Bar Bending Schedules**

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 **Cleaning**

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 **Cutting & Bending of Reinforcement**

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding**

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 **Cold Weather Concreting**

When conditions are such that any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 **Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by pre-cooling, post-cooling or any other method, if required, will be specified and paid for separately.

3.19.00 **Concreting under Water**

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 **Form Work**

3.20.01 **General**

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 **Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Separol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 **Design**

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pourer of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sq.m excluding weight of concrete.

30.20.04 **Inspection of Forms**

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 **Removal of Forms**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE-VI

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature Deg.C				Temperature Deg.C			
	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.-Below 5 Deg.	5 Deg.	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.- Below 5 Deg.	5 Deg.
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove	1	1	1	Do not remove
b) Beam sides	3	2	3	forms until site cured	2	1	1	forms until
c) Slabs, 125 mm	10	7	8	test speci-	7	4	5	site
d) Slabs over 125mm thick and soffit of minor beams	18	14	16	men develop at least 50% of the specified 28 days strength	12	8	9	cured test specimen develop at least 50% of the specified 28
e) Soffit of main beams	24	21	22		14	10	12	days strength

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.06 **Tolerance**

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer :

For :	a)	Sectional dimension	-	$\pm$ 5 mm
	b)	Plumb	-	1 in 1000 of height
	c)	Levels	-	$\pm$ 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 **Re-use of Forms**

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 **Classification**

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer :

a) Ordinary

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-se may only be permitted after special inspection and approval by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

c) Ornamental

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 **Opening, Chases, Grooves, Rebates, Blockouts etc.**

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 **Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures**

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75 Deg.C
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 **Joint Sealing Compound**

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 **Isolation Joints**

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 **Rubber Pad**

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 **Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stonechips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shink, free flow, cementitious grout like "Sikagrout 214 / Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 **Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" or approved equivalent, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N/Sq. mm
Flexural Strength	-	25 to 30 N/Sq. mm.
Tensile strength	-	15 N/Sq. mm (approx.)
Bonding strength to concrete	-	3 N/Sq. mm (approx.)
Bonding strength to steel	-	20 N/Sq. mm (approx.)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 **Waterproofing Admixtures**

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%.

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, a melamine based super plasiticizer will be preferable.

a) In concrete : The admixture shall be procured from reliable and reputed manufacturers and approved by the engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 **Bituminous or Tar Coating on External Surface**

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.05 **Protective Coating on Inside Surface**

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 **Bitumen Felt : Application for Tanking**

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be Hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialised firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 **Polyethylene Films : Application in Walls or base of Structures**

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum.

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm brown craft paper laminated similar to (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 **Protective coating on Concrete Surface**

3.27.01 **On Foundation**

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using rubber/bitumen emulsion protective coating of approved manufacturer.

3.28.00 **Waterproofing by Pressure / Chemical Grouting**

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 **SAMPLING AND TESTING**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 **Cement**

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him without any expense to the owner. In case due to any circumstances, the

agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 **Aggregates**

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 **Water**

Sampling and Testing of water being used for concrete works as per IS:3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS:3025 & IS:456.

4.05.00 **Admixture**

4.05.01 **Air Entraining Agents (A.E.A)**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 **Other Admixtures**

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner.

4.06.00 **Concrete**

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to Clause 9.2.4 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 LIST OF IS : CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :

IS : 73 - Indian Standard Specification for Paving Bitumen.

IS : 216 - Indian Standard Specification for Coal Tar Pitch.

IS : 269 - Indian Standard Specification for 33 grade Ordinary Portland Cement.

IS : 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

IS : 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part-1 & 2.

IS : 455 - Indian Standard Specification for Portland Slag Cement

IS : 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

IS : 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures.

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete.

IS : 737 - Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose.

IS : 1199	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
IS : 1200	-	Indian Standard Specification for Method of (Part-V) Measurement of Formwork.
IS : 1322	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing.
IS : 1489	-	Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2.
IS : 1566	-	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
IS : 1609	-	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts.
IS : 1786	-	Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement.
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers.
IS :1834	-	Indian standard specification for hot applied sealing compound for joint in concrete.
IS : 2062	-	Steel for general structural purpose.
IS : 2185	-	Indian Standard Specification for Hollow and solid/ solid light wt. Cement Concrete Blocks - Part-1 & 2.
IS : 2210	-	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates.
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII.
IS : 2430	-	Indian standard specification for method of sampling of Aggregate for concrete.
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement.
IS : 2505	-	Indian Standard Specification for Concrete Vibrators Immersion Type.
IS : 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators.

IS : 2514 - Indian Standard Specification for Concrete Vibrating tables.

IS : 2645 - Integral Cement water proofing compound.

IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type).

IS :2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part-1 : Pull out Test.

IS : 3025 - Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & Waste Water - part-1 to 37.

IS : 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.

IS : 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4.

IS : 3384 - Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing.

IS : 3414 - Code of practice for Design and Installation of joints in Buildings.

IS : 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry.

IS : 3558 - Code of Practice for use of Immersion Vibrators for Consolidating Concrete.

IS : 3696 - Safety Code for Part-1 : Scaffolding and Part 2: Ladders.

IS : 3812 - Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture.

IS : 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement - Part-1 to 14.

IS : 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.

IS : 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches.

IS : 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers.